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VOLUME 17, NUMBER 1
JANUARY 1984

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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
U.S. Department of the Interior

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The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 30, 1985.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientitsts, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey, MS 421
Reston, VA 22092

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Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1B. Aqueous Solutions and Suspensions

A METHOD FOR CALCULATING THE RATE OF BIOSEDIMENTATION THROUGH THE LOWER BOUNDARY OF THE PHOTOSYNTHETIC ZONE IN SEA WATER,
Institute of Biology of the Southern Seas, Sevastopol (USSR).
V. N. Yegorov, V. N. Ivanov, and L. V. Migal.
Hydrobiological Journal, Vol 17, No 4, p 69-74, 1981. 3 Fig, 15 Ref.

Descriptors: *Sea water, *Biosedimentation, Sedimentation, Photosynthesis, Vertical flow, Vertical distribution, Water chemistry, Uranium-238, Thorium-234, *Indian Ocean.

An attempt was made to calculate the rate of water exchange in the euphotic layer on the basis of data about its productivity and on the vertical distribution of various forms of zinc. Use was made of the balance equations for zinc and Th-234 to analyze both the rate of biosedimentation and the velocity of water exchange in the euphotic layer. Studies were based on data from a test area in the Indian Ocean. The rate of water exchange through the lower boundary of the photosynthetic zone and the biosedimentation potential of the euphotic layer could be calculated on the basis of simultaneous observations of the vertical distribution of a trace element (zinc) and the shift in the equilibrium concentrations of uranium 238 and thorium 234. The errors of the method are discussed. (Baker-FRC)
W84-00143

2. WATER CYCLE

2A. General

MODELING SURFACE AND SUBSURFACE STORMFLOW ON STEEPLY-SLOPING FORESTED WATERSHEDS,
Kentucky Water Resources Research Inst., Lexington.
For primary bibliographic entry see Field 4D.
W84-00032

IMPROVED METHODS AND GUIDELINES FOR MODELING STORMWATER RUNOFF FROM SURFACE COAL MINED LANDS,
Kentucky Water Resources Research Inst., Lexington.
For primary bibliographic entry see Field 4C.
W84-00033

HYDROLOGY OF A SMALL IMPOUNDMENT AND WATERSHED IN CENTRAL OKLAHOMA,
Agricultural Research Service, Chickasha, OK.
R. Schoof.
Water Resources Bulletin, Vol 19, No 1, p 15-21, February, 1983. 4 Fig, 6 Tab, 9 Ref.

Descriptors: *Watershed, *Impoundments, *Hydrology, *Oklahoma, Runoff, Rainfall-runoff relationships, Evapotranspiration, Evaporation, Bitter Creek.

An analysis is presented of a site impoundment's water budget for five years of record, along with a study of the temporal and spatial distribution of water yield from the contributing watershed, measured from 1972 through 1980. On-site loss of water from the impoundment was only 17% of the inflow during three years when the annual precipitation averaged 26 inches and the annual inflow averaged 1.4 inches. Runoff from an eroded area with no farm ponds was about 70% greater per unit area than from a portion of watershed where 71% of the drainage area was controlled by farm ponds. Loss of top soil increased runoff significantly. Only 24% of the total runoff into the impoundment was base flow. The flow rate into the impoundment was less than 0.05 cfs 70% of the time, and the inflow rate exceeded 10 cfs only 1% of the time. SCS runoff curve numbers varied between 57 and 96 for the impoundment watershed, with an inverse relation between precipitation amount and curve number, apparently caused by partial area runoff from impervious and semi-impervious areas. A comparison of measured event runoff computed by the SCS curve numbers gave an r sq of only 0.44. However, the total computed surface runoff for eight years of record was less than 1% below the measured runoff, which indicated that the curve number method was a good tool for predicting long term runoff for the watershed. (Baker-FRC)
W84-00098

CONSTANT VELOCITY KINEMATIC ANALYSIS OF AN INFILTRATING MICROCATCHMENT HYDROGRAPH,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
Y. Zarmi, J. Ben Asher, and T. Greengard.
Water Resources Research, Vol 19, No 1, p 277-283, February, 1983. 3 Fig, 2 Tab, 17 Ref.

Descriptors: *Infiltration, *Surface flow, *Water harvesting, Arid lands, Hydrodynamics, Rainfall intensity, Hydrographs, Flow patterns, Overland flow, Flow velocity, Soil properties, Runoff.

This paper describes the development and testing of a physical model to predict the hydrodynamic processes on a natural microcatchment of about 200 sq m, which is the size needed in arid zones for providing irrigation water for one tree. Rainfall was applied to a 125 sq m catchment with a fairly uniform grade of 1%. The recession parts of the hydrographs were similar for rainfall intensities of 60, 40, 20, and 10 mm per hour. Recession lasted about 10 min and was independent of the surface detention. Recession limbs of the hydrographs decreased very rapidly the moment the rain stopped and appeared as a series of parallel, nearly perpendicular lines on the discharge vs. time plot. It was possible to assume that the velocity of water flow on the surface was constant, independent of time or position along the catchment. This allowed the analytical solution of the continuity equation to be simplified, providing better insight into the problem of surface flow. (Cassar-FRC)
W84-00111

RUNOFF MODEL FOR WATERSHEDS OF NONHOMOGENEOUS HYDROLOGIC CHARACTERISTICS,
New Mexico Univ., Albuquerque. Dept. of Civil Engineering.
R. J. Heggen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113596, Price codes: A07 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute Technical Report No. 176, Las Cruces, September 1983. 136 p, 11 Fig, 6 Tab, 54 Ref, 5 Append. OWRT A-068-NMEX(1), 14-34-0001-2133.

Descriptors: *Small watersheds, *Hydrologic models, Runoff, Watershed studies, *Flood routing, Water yield, Infiltration, *Watershed models, Model studies, New Mexico, Four Hills watershed, North Camino watershed.

A Watershed of any configuration, topography, spatial distribution of cover and soil, and channel characteristics is described as non-homogeneous finite-element surface grid. Time-varying precipitation is applied to the watershed and runoff is hydraulically routed over the surface in discrete time increments. Infiltration is abstracted by a variable rate model derived from SCS curve numbers. Precipitation infiltrates, stands, and/or runs off each quadrant in accordance with that quadrant's slope and hydrologic characteristics. Overland flow is routed to channels, and channel flow is then routed to the basin's point of discharge. The grid definition of the watershed surface makes the model appropriate for watershed not adequately modeled by conventional, nondistributed hydrologic means. The model does not require that unit hydrographs or times-of-concentration be estimated.
W84-00137

HYDROGEOLOGY (HYDROGEOLOGIE),
Centre National de la Recherche Scientifique, Moulis (France). Lab. Souterrain.
A. Mangin.
Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie 2: Mecanique-Physique, Vol 293, No 14, p 1011-1014, 1981. 3 Fig, 8 Ref.

Descriptors: *Hydrographs, *Hydrograph analysis, Discharge hydrographs, Rainfall, Simulation analysis, Mathematical studies.

The application of cross correlation and cross spectral analysis to rainfall and discharge time series leads to a better hydrological system identification through improved results from unit hydrographs, their analysis with respect to the functioning of the hydrological systems, and quantitative estimation of source parameters, such as linearity. These factors constitute a valuable step for the investigation of system simulation. (Author's abstract)
W84-00310

TRENDS IN THE VARIATION OF SURFACE WATERS OF THE HYDROSPHERE,
R. K. Klige.
Water Resources (English Translation), Vol 9, No 3, p 272-284, May-June, 1982. 5 Fig, 4 Tab, 40 Ref. Translated from Vodnye Resursy, No 3, p 92-105, May-June, 1982.

Descriptors: *Surface water, *Temperature effects, *Water exchange, *Water resources, World ocean, Evaporation, Global water, Hydrosphere, Geohydrology, Groundwater hydrology, Water levels.

In order to correctly understand current changes and trends in surface waters of the hydrosphere a determination was made of the processes of evolution of natural waters that led to their present state. In this connection the paleohydrologic conditions for individual successive time segments were reconstructed. Specific time periods included the earth's early stages of geologic history, Early Makhachkala, Shikhova, Late Makhachkala, Begdash, Sartas, Julala, Dagestan, Zhelanda, Gousan, Izberbash, Turala, Aleksandrbai, Uluchaevo, Abeskun, the late history and the present time. The very early stages of earth's geologic history were also included along with the Phanerozoic period and the late Paleozoic period. An investigation of global water-exchange processes shows that under the existing climatic conditions and in the future a directed change in the components of the water balance of the earth's surface will occur as a result of which land water supplies will be reduced by about 133 cubic km/yr and the volume of glaciers by 183 cubic km/yr with further replenishment of the World Ocean at a rate of 316 cubic km/yr. Modeling of changes in the conditions of global water exchange are considered for temperature changes of 1 and 2.5 degrees. (Baker-FRC)
W84-00316

WATER BALANCE OF THE BLACK SEA IN THE LATE VALDAI GLACIAL EPOCH,
Moscow State Univ. (USSR).
S. I. Varushchenko.
Water Resources (English translation), Vol 9, No 3, p 311-313, May-June, 1982. 2 Tab, 11 Ref. Translated from Vodnye Resursy, No 3, p 136-138, May-June, 1982.

Descriptors: *Water resources, *Water balance, *Geohydrology, Hydrosphere, Water exchange, Glaciers, Europe, USSR, Don River, Danube River, Dnestr River, Dnepr River, Black Sea.

On the basis of the bathygraphic curve, the areas and volumes of water are calculated for the Black Sea for two levels: the early maximum level of the Bosporus sill (-35 m) and the surface corresponding to the present day 95-m depth of the sea. The first level, having an area of about 402,000 sq km,

dates to the epochs of detachment and subsequent joining of the water body to the Mediterranean Sea, and the second, having an area of about 367,000 sq km, corresponds to the average level of development of the deepest New Euxine lake terraces of those expressed in the bottom relief. The data presented permit an approximate determination of how much the mean annual runoff to the New Euxine Lake decreased in the time interval from 29,000 to 9000 years ago compared to the present runoff to the Black Sea. Since from 85 to 90% of the surface waters in the New Euxine Lake came from rivers emptying into it from the north, it is concluded that the main cause of the drop of the level of this water body after its detachment from the ocean was the abrupt and very substantial reduction of the volume of river runoff from the periglacial region of the glacier during its occurrence and stabilization in the maximum phase of development. In the initial and final stages of development of the glacier the runoff was about two times and at the maximum possibly even twelve times less than the present day. The data indicate that during the last glaciation the basins of the Danube, Dnestr, Dnepr, and Don were in a zone of quite feeble moistening. The calculations indicate an exceptionally dry climate in the area and indirectly confirm the possibility of the wide development of tundra steppes in the indicated period in southern Europe. (Baker-FRC)
W84-00332

THE HYDROLOGICAL SUSA-STUDY,
Technical Univ. of Denmark, Lyngby. Inst. of Hydrodynamics and Hydraulic Engineering.
E. Hansen, and M. Dyhr-Nielsen.
Nordic Hydrology, Vol 13, No 5, p 257-262, 1982. 2 Fig.

Descriptors: *Rainfall-runoff relationships, *Model studies, Hydrologic models, Denmark, Hydrology.

A short description is offered of a 4.5 year hydrological research project constituting a Danish contributon to UNESCO's International Hydrological Program. The main objectives of the project were to study the hydrologic processes in a catchment with a regional confined aquifer covered by boulder clay; the consequences of increased ground water development on groundwater hydraulic heads and streamflow; the possibilities of establishing an integrated water resources development, taking into account joint effects of water abstraction and sewage disposal on the water quantity and quality of the streams in the catchment. Field studies of hydrological processes were conducted for precipitation, evapotranspiration, subsurface runoff, groundwater recharge, hydrogeology, interaction between groundwater and surface water, runoff and lake storage, and chemistry of ground- and surface water. Mathematical modeling of hydrological processes and systems were constructed for evapotranspiration, groundwater, rainfall-runoff, and integrated hydrologic models. (Baker-FRC)
W84-00338

ESTIMATION OF THE VOLUME OF REGENERATED WATER OF THE CONTINENTAL CRUST IN GLOBAL WATER EXCHANGE,
O. M. Rozen.
Water Resources (English Translation), Vol 9, No 3, p 285-297, May-June, 1982. 4 Fig, 6 Tab, 50 Ref. Translated from Vodnye Resursy, No 3, p 106-118, May-June, 1982.

Descriptors: *Water exchange, *Water resources, *Hydrosphere, *Geohydrology, World Ocean, Paleohydrology.

An attempt has been made to estimate the balance of buried water and water released from volcanogenic-sedimentary rocks during the formation of the earth's crust. The examination of the indicated balance was limited to only two principal forms of burial of water: first, water present in the crystal lattice of minerals of sedimentary rocks and amenable to a theoretical quantitative estimation, and second, water filling the pores of sedimentary rocks and which is to a considerable extent relict and syngenetic, a quantitative estimation of which can be made on the basis of the data on the total porosity of sedimentary rocks. The data obtained show that during the formation of both the lower and upper horizons of the continental crust vast amounts of water were buried, which are quite close to those calculated for interstitial waters of nonmetamorphosed deposits and equal to about 20% of the entire hydrosphere. They exceed by an order of 1.5 the mass of ice, rivers, lakes, and water in the atmosphere taken together. The amount of water buried in rocks during the entire history of the earth amounts to 60% of the entire hydrosphere. The release of such masses of water led to a change in the volume of the World Ocean. For estimating such a flow of water it is assumed that it occurred in each of the principal epochs of metamorphism and granitization in the Precambrian period. Bulging up of granitoids and orogeny, leading to the geologically instantaneous supply of a large amount of terrigenous material to the ocean, are an important accompanying consequence of global epochs of metamorphism. The combination of an increase in the volume of water and its displacement by the incoming terrigenous sediments should have led to an increase of its level and to transgressions. The periodic rises of the World Ocean level were probably originally quite intense, gradually decreasing in intensity with the passage of time. (Baker-FRC)
W84-00345

INTERRELATIONSHIP BETWEEN RELIEF, GLOBAL CLIMATE, AND WATER EXCHANGE,
L. V. Zorin.
Water Resources (English Translation), Vol 9, No 3, p 329-334, May-June, 1982. 44 Ref. Translated from Vodnye Resursy, No 3, p 156-161, May-June, 1982.

Descriptors: *Water exchange, *Geohydrology, *Water resources, World Ocean, Temperature effects, Climate, Water balance, Hydrosphere, Advection, Convection.

The effect of the relief on global climate and water exchange is investigated. Along with the paleogeographic aspect the present day aspect of the relation between continental relief and water balance is considered. It is noted that the amount of solar energy received by the earth periodically changed to extents which caused fluctuations of the climate and water exchange and the occurrence of glaciation and pergelation. Variations of the climate and water exchange, having a periodic large-scale character, were related mainly to the geotectonic evolution of the earth. There are direct indications that glaciation on the earth actively degrades; having reached a maximum in the Middle Pleistocene, it expanded in surges but on a considerably smaller scale in the Upper Pleistocene and in the Little Ice Age. Presently global glaciation is decreasing, which is displayed in unstable melting of present-day glaciers of both the mountain and, in part, flatland types and also of permafrost. It is concluded that the more complex the relief, the more complex the processes of advection and the more active the processes of convection. More complex reliefs also call for greater complexity in the circulation processes and for a more complicated process of large-scale condensation occurring on land. In epochs of plantation and denudation of mountains, that is, in epochs of cessation or slowing of global expansion, equalization of the climate will occur, accompanied by melting not only of mountain glaciers but also of the polar ice caps. The climate will become ordered, and water exchange will stabilize, with natural waters concentrating in the oceans. (Baker-FRC)
W84-00346

2B. Precipitation

CHEMICAL COMPOSITION AND SPATIAL VARIATION OF BULK PRECIPITATION AT A COASTAL PLAIN WATERSHED IN SOUTH CAROLINA,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
D. D. Richter, C. W. Ralston, and W. R. Harms.
Water Resources Research, Vol 19, No 1, p 134-140, February, 1983. 4 Fig, 3 Tab, 37 Ref.

Descriptors: *Precipitation, *Spatial variation, *Chemical composition, Water pollution sources, Fate of pollutants, *South Carolina, Phosphates, Sulfates, Nitrates, Ammonium, Hydrogen ion concentration, Rain, Chlorides, Potassium, Sodium, Magnesium, Calcium, Forest watersheds, Nutrients.

Ionic constituents of rain water were determined in samples from 8 stations in a 500-ha watershed in the Francis Marion National Forest, located in the coastal plain of South Carolina. Mean annual deposition rates of ions (kg per ha) were: $H+$, 0.64; $Ca(++)$, 5.69; $Na+$, 5.66; $Mg(++)$, 1.68; ammonium-N, 0.83; $K+$, 0.94; sulfate-S, 7.51; chloride, 14.2; nitrate-N, 1.76; and phosphate-P, 0.12. Spatial variations were $<$ 10% for sulfate-S, nitrate-N, and $Ca(++)$; intermediate for $Mg(++)$, chloride, $H+$, and $Na+$; and 30-35% for ammonium-N, phosphate-P, and $K+$. Sources of the various constituents were oceanic salts, fossil fuel combustion, natural biogenic processes, agricultural activities, and soil-derived particulates. For this watershed 19 sample collectors would be sufficient to estimate annual bulk precipitation inputs within 10% of true mean for sulfate, nitrate, $Ca(++)$, $Mg(++)$, chloride, $H+$, and $Na+$, whereas 35 collectors would be required to provide similar confidence intervals for ammonium, phosphate, and $K+$. (Cassar-FRC)
W84-00108

A POINT PROCESS MODEL OF SUMMER SEASON RAINFALL OCCURRENCES,
Interstate Commission on the Potomac River Basin, Rockville, MD.
J. A. Smith, and A. F. Karr.
Water Resources Research, Vol 19, No 1, p 95-103, February, 1983. 24 Ref.

Descriptors: *Rainfall, *Drought, *Cluster analysis, Model studies, Seasonal variation, Precipitation, Potomac River Basin, Meteorology, Stochastic hydrology, *Model studies, *RCM processes.

A point process model of summer season rainfall occurrences is developed. The model, which is termed an RCM process (renewal Cox process with Markovian intensity), is a member of the family of Cox processes (Poisson processes for which the rate of occurrence of events varies randomly over time). Model development is based on counts and interarrival time statistics estimated from Potomac River basin rainfall data. The counting parameters used are the conditional intensity function, index of dispersion and counts spectrum; the interarrival time parameters are the coefficient of variation and the autocorrelation function. Explicit results are presented for the counts and interarrival time parameters of RCM processes. For the RCM process the rate of occurrence alternates between two states, one of which is 0, the other positive. The form of the intensity process suggests that clustering of summer season rainfall occurrences in the Potomac River basin results form the alternation of wet and dry periods. Computational results are presented for two extensions of the RCM process model of rainfall occurrences: a marked RCM process model of rainfall occurrences and associated storm depths and a bivariate RCM process model of rainfall occurrences at two sites. (Author's abstract)
W84-00117

A SIMPLE PROCEDURE FOR CALCULATING ATMOSPHERIC WATER VAPOR CONCENTRATION,
California Inst. of Tech., Pasadena.
G. J. McRae.
Journal of the Air Pollution Control Association, Vol 30, No 4, p 394, April, 1980. 2 Ref.

Descriptors: *Water vapor, *Mathematical equations, *Relative humidity, Mathematical studies, Air temperature, Atmospheric pressure.

A simple procedure, accurate to 0.5% over a range of plus or minus 50 degrees, is presented for calculating water vapor concentration without the use

of psychrometric charts or tables. The mathematical equation which equates relative humidity to the ratio of the mole fraction of water vapor in the moist atmosphere to the mole fraction at saturation is rewritten using Dalton's gas laws and Richards' polynomial expression. The resultant expression allows the determination of water vapor concentration in parts per million units or in other unit systems by straightforward conversion. (Geiger-FRC)
W84-00304

METHODS FOR CALCULATING AREAL PRECIPITATION - APPLIED TO THE SUSA-CATCHMENT,
Danish Meteorological Inst., Copenhagen.
P. Allerup, H. Madsen, and J. Riis.
Nordic Hydrology, Vol 13, No 5, p 263-278, 1982. 18 Fig, 1 Tab, 13 Ref.

Descriptors: *Rainfall distribution, *Terrain analysis, *Wind, Susa catchment, Catchment areas, Hills, Rainfall, Distribution, Topography.

In order to study the influence of the terrain on the precipitation pattern in the Susa catchment, a separate raingauge setup was established in two hilly areas. Before calculation of real precipitation could be carried out, correction of precipitation due to systematic errors was needed. A special method, the TTSE method, was developed to take into account the terrain characteristics. The Susa catchment is characterized by a gently undulating landscape surrounding the Susa and its tributaries. Ranges of hills rise 20-30 m above the surrounding landscape in some areas and 80-90 m in others. A statistical model study was carried out to analyze the data collected from the raingauge network. It appeared from the study that both the existence of small hills and the direction of the wind influence the amount of precipitation a given area will receive. (Baker-FRC)
W84-00342

2C. Snow, Ice, and Frost

ICE BREAKUP AND JAMMING OBSERVATIONS ALONG THE MACKENZIE RIVER,
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
J. W. Kamphuis, and J. R. Moir.
Canadian Journal of Civil Engineering, Vol 10, No 1, p 78-91, 1983. 14 Fig, 1 Tab, 2 Ref.

Descriptors: *Ice breakup, *Ice jams, *River flow, Floating ice, Mackenzie River, Melting.

Ice breakup in the northerly flowing Mackenzie River, Canada, between Forts Simpson and Good Hope was studied in 1979-1981. This paper reports the observations made from 40 aircraft flights in 1980-81. Shortly before initial downstream movement of the ice open water is seen around islands, along main shores, over shoals, and in shallow secondary channels, with remnants of shorefast ice in the apparently open water areas. In deep straight reaches the river is almost entirely covered with a solid floating ice sheet. Ice begins to move downstream when the forces keeping the ice in place are exceeded by the driving forces (gravity, shear stress on the bottom of the ice, and form drag by the flow on the ice sheet). Ice movement begins in the shallow, braided sections, forming a mush of relatively small pieces with some larger flows. Moving downstream, the mush encounters more solid ice in the straight stretches, pushing on it until the sheet moves as a unit for up to 1 km. Thickening occurs in the downstream section of the mush and along the shores. Several jams, separated by open water, appear in a river simultaneously. Release of the jam may occur by movement of the whole ice mass or by downstream movement of the mush through failures in the solid ice sheet or under the ice sheet. Breakup, rate of breakup, and jam clearing are dependent on the strength of the ice, air temperature, and wind velocity. (Cassar-FRC)
W84-00071

2D. Evaporation and Transpiration

EVAPORATIVE LOSSES FROM COOLING PONDS,
Clemson Univ., SC. Dept. of Civil Engineering.
B. L. Sill.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111863, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Research Institute Report No 110, Clemson Univ., S.C., September 1983. 47 p, 10 Fig, 4 Tab, 34 Ref. OWRT A-052-SC(1), 14-34-0001-1143-2143,0143.

Descriptors: *Evaporation, *Evaporation Rate, *Cooling ponds, *Waste heat, *Convection, Water loss, Water consumption, Lakes, Thermal pollution.

Cooling ponds have been routinely utilized for the dissipation of industrial waste heat. A by-product of this application is an increase in evaporative losses over the naturally occurring value. The present study describes some analyses of this evaporation and means to measure and/or calculate it. Mathematical models using an energy budget approach are shown to be least sensitive to errors in the wind speed function. The second portion of the study examines the relative effects of evaporation resulting from free convection (zero windspeed) and forced convection. A new evaporation equation for heated and nonheated lakes is presented.
W84-00046

2E. Streamflow and Runoff

RECOVERY PATTERNS IN STREAM COMMUNITIES IMPACTED BY THE MT. ST. HELENS ERUPTION,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
For primary bibliographic entry see Field 5C.
W84-00039

IMPACT OF DROUGHT ON QUALITY OF POTENTIAL WATER SUPPLY SOURCES IN THE SANGAMON RIVER BASIN,
Southern Illinois Univ. at Carbondale. Dept. of Thermal and Environmental Engineering.
C. B. Muchmore, and B. Dziegielewski.
Water Resources Bulletin, Vol 19, No 1, p 37-46, February, 1983. 6 Fig, 5 Tab, 10 Ref.

Descriptors: *Water quality, *Drought, *Water supply, Water resources development, Ammonia, Manganese, Phenols, Specific conductance, Rivers, River basins, Streamflow, *Illinois, Sangamon River basin.

An analysis was made of streamflow and several water quality parameters in six Illinois rivers. The analysis showed that the 1976-77 drought produced significant streamflow deficiencies in the investigated streams of the 5,000 sq mile basin of the Sangamon River. Temporal and spatial variability of precipitation deficits within the basin had insignificant effects on the differentiation in timing of extremely low flows among various streams. The impact of drought on water quality was less uniform than the impact on streamflow. Overall, streamflow quality deteriorated, as a result of abnormally high concentrations of ammonia, maganese, and to a lesser extent, phenol and specific conductance. Significant decreases in concentrations of nitrites and nitrates, coliform bacteria, and total iron were noted. The approach to the analysis of water quality, using 12-month moving averages of monthly quality measurements, proved to be sensitive enough to clearly isolate the impact of drought from seasonal fluctuations in water quality. The analysis of instream flow and moving averages of nitrogen species concentrations revealed two distinct patterns of response to drought. They corresponded to streams chararcterized by an alternately high or low contribution of treated municipal effluent to low flow. The effects of land use patterns on water quality during the drought were hard to isolate due to the relative similarity of land uses for all investigated subbasins. However, the more general thesis regarding the significant differences in response to drought among various streams seems to be substantiated in the case of impacts on water quality. It is suggested that streams which are considered unsuitable for municipal supply due to high levels of the quality indicators studied may be used as emergency sources during droughts. (Baker-FRC)
W84-00105

EXTREMAL HYPOTHESES FOR RIVER BEHAVIOR,
Canterbury Univ., Christchurch (New Zealand). Dept. of Agricultural Engineering.
T. R. H. Davies, and A. J. Sutherland.
Water Resources Research, Vol 19, No 1, p 141-148, February, 1983. 2 Fig, 1 Tab, 38 Ref.

Descriptors: *Energy dissipation, *River flow, *Friction, Streamflow, Turbulent flow, Laminar flow, Alluvial rivers, Minimization hypotheses, Sediment transport.

The hypotheses of minimum energy dissipation, minimum stream power, and minimum unit stream power are summarized and compared. Their derivation from analogies with laminar flow and linear thermodynamics is criticized on the grounds that these situations differ fundamentally from river flows, which are usually highly turbulent and strongly nonlinear. The authors' empirical hypothesis of maximum friction factor seems preferable to the minimization hypotheses because it is compatible with the known behavior of turbulent flows and nonlinear processes, it is applicable with a wider range of independent variables, and it is more in keeping with trends shown by experimental data under all constraints. The minimization hypotheses seem likely to give incorrect predictions when flow rate and depth are independent variables. The empirical success of the minimization hypotheses is confined to situations in which they predict similar behavior to the maximum friction factor hypothesis; they may be considered as special cases of this more general hypothesis. (Author's abstract)
W84-00129

A TIME DEPENDENT, TWO-LAYER FRONTAL MODEL OF BUOYANT PLUME DYNAMICS,
Delaware Univ., Newark. Coll. of Marine Studies.
J. O'Donnell, and R. W. Garvine.
Tellus, Vol 35A, No 1, p 73-80, 1983. 7 Fig, 19 Ref.

Descriptors: *Mathematical equations, *Plumes, *Buoyancy, Mississippi River, Connecticut River, Rivers, Dynamics.

The one-dimensional, time dependent behavior of a two-layer frontal model is considered in a study of the dynamics of buoyant plumes such as those observed at the mouths of the Mississippi and Connecticut Rivers. The long wave equations are solved numerically with several different boundary conditions in order to illustrate some of the properties of the model. The results of the four numerical experiments performed demonstrated that the frontal motion of buoyant plumes is strongly controlled by the flow at the inlet. Control is exerted by the generation of internal waves which propagate toward the front, where they modify the flow. If changes in the inlet flow occur with short time scales, then these internal waves can develop into surges or bores which would effectively increase the amount of interfacial mixing. These results, together with those of Garvine, encourage the extension of this model and its numerical solution technique to two horizontal dimensions in order to more closely approximate the behavior of natural buoyant plumes. (Baker-FRC)
W84-00178

COMMENT ON 'OPTIMAL RISK-BASED DESIGN OF FLOOD LEVEE SYSTEMS' BY Y.-K. TUNG AND L. W. MAYS,
Tiszadata Consulting Engineers, Budapest (Hungary).
I. Bogardi, and L. Duckstein.

Water Resources Research, Vol 18, No 6, p 1745-1746, December, 1982. 6 Ref.

Descriptors: *Levees, *Flood routing, Flood protection, Optimization, Design criteria, Dynamic programming.

A comment on the above titled paper, published in Water Resources Research, Volume 17, No 4, pages 843-852, 1981, states that the assumption that no routing techniques are applied to route the flood hydrography through the levee system does not take into account the observation that flooding in an upstream reach decreases the peak stage in the downstream reaches. Closed loop methods are proposed as alternatives to this open loop method. (Cassar-FRC)
W84-00350

2F. Groundwater

A CASE STUDY OF DRY WELL RECHARGE,
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 5E.
W84-00013

AN EIGENVALUE NUMERICAL TECHNIQUE FOR SOLVING UNSTEADY LINEAR GROUNDWATER MODELS CONTINUOUSLY IN TIME,
Servicio Geologico de Obras Publicas, Madrid (Spain).
A. Sahuquillo.
Water Resources Research, Vol 19, No 1, p 87-93, February, 1983. 14 Ref.

Descriptors: *Groundwater management, *Groundwater movement, *Aquifers, Differential equations, Eigenvalues, Numerical analysis, Piezometric head, Leaky aquifers, Confined aquifers, Pumping.

A procedure is presented for solving the differential groundwater flow equation. Using a finite difference or finite element discretization scheme, a set of simultaneous linear equations is obtained. The eigenvalues and eigenvectors of a matrix, which is a function of the coefficients of the set, are the key to the solution. A vector (L) is obtained straightforwardly by combining the eigenvector matrix (A), the eigenvalue vector, the pumping vector (P), and the initial head vector. Vector L, which depends on time, can be expressed simply and explicitly as a function of the eigenvalues. Piezometric heads can be obtained by combining A and L. L is the only vector that needs to be computed as P changes with time. In this way, influence functions of a piezometric head, flow velocity, and flow depletion of a stream connected with the aquifer under a unit stress can be obtained explicitly and continuously in time. The method can be applied to confined as well as to leaky aquifers and to one-, two-, or three-dimensional linear models. Its main advantage lies in the fact that it is unnecessary to repeatedly solve a matrix for every time increment. The method is particularly useful for groundwater management problems in which a large number of alternatives have to be evaluated. (Author's abstract)
W84-00083

AQUIFER PARAMETER IDENTIFICATION WITH KRIGING AND OPTIMUM PARAMETERIZATION,
California Univ., Los Angeles. School of Engineering and Applied Science.
W. W. G. Yeh, Y. S. Yoon, and K. S. Lee.
Water Resources Research, Vol 19, No 1, p 225-233, February, 1983. 9 Fig, 4 Tab, 17 Ref.

Descriptors: *Aquifer properties, *Parametric hydrology, Groundwater movement, *Kriging.

A new parameter identification method is developed for a two-dimensional, unsteady state groundwater flow model. The method is a direct approach, as it requires no iterative searching of parameters. The unknown functional coefficients (parameters) are optimally determined by a generalized matrix inversion scheme. Kriging, an unbiased minimum variance estimator, is used as a presampling filter to reconstruct the head distribution for the entire flow domain. The ill-posedness of the inverse problem as characterized by instability and nonuniqueness is controlled by reparameterization utilizing the technique of finite elements. A set of statistics was developed to quantify explicity the tradeoff between the system modeling error and the error associated with the parameter uncertainty. These two types of errors were shown to be a function of the parameter dimension. Residual mean square and trace of the covariance matrix of the estimated parameters served as good indicators for the determination of the optimum parameter dimension. A set of numerical experiments was conducted to illustrate the methodology. (Author's abstract)
W84-00085

HEAT TRANSFER IN FRACTURED GEOTHERMAL RESERVOIRS WITH BOILING,
California Univ., Berkeley. Lawrence Berkeley Lab.
K. Preuss.
Water Resources Research, Vol 19, No 1, p 201-208, February, 1983. 10 Fig, 1 Tab, 20 Ref.

Descriptors: *Heat transfer, *Geothermal studies, *Porous media, Geologic fractures, Enthalpy, Permeability, Injection wells.

Nonisothermal flow of water and steam in idealized fractured porous media was studied with analytical and numerical techniques. Several conclusions were reached. The behavior of fractured boiling reservoirs can be different from porous medium-type reservoirs with the same permeability and porosity, even in cases where fracture spacing is small. Heat transfer to fractures by conduction is very important if matrix permeability is low. For production without reinjection reservoir response depends more strongly upon matrix permeability than on fracture spacing. It is possible that fractured geothermal reservoirs may produce superheated steam even in the presence of large quantities of liquid water flowing in the matrix. Full reinjection can be effective for maintaining pressure in fractured reservoirs. Excellent thermal sweeps can be achieved even in cases with large fracture spacing (several hundred meters) unless major short circuits in fractures are present. (Cassar-FRC)
W84-00086

A NUMERICAL PROCEDURE FOR THE SOLUTION OF THE STEADY STATE VARIABLE DENSITY GROUNDWATER FLOW EQUATION,
Geological Survey, Austin, TX. Water Resources Div.
L. K. Kuiper.
Water Resources Research, Vol 19, No 1, p 234-240, February, 1983. 3 Fig, 11 Ref.

Descriptors: *Groundwater movement, *Saline water intrusion, *Spatial variation, Density, Finite difference methods, Pressure head.

A numerical code is developed for the solution to the three-dimensional steady state groundwater flow equation in which groundwater density varies with spatial position and is treated as a known spatially dependent parameter. The integrated finite difference grid elements of the numerical code are rectangular when viewed along the vertical direction, but their top and bottom surfaces parallel or are coincident with the interfaces between the geologic strata within the solution region. Conditions that are sufficient for the accuracy of the code are derived. Approximate solutions for pressure head, as determined from the code, are compared for accuracy with several exact analytic test solutions. (Author's abstract)
W84-00087

SIMULATION OF SALT WATER-FRESH WATER INTERFACE MOTION,
Valencia Univ. (Spain).
J. Ferrer Polo, and F. J. Ramos Ramis.
Water Resources Research, Vol 19, No 1, p 61-68, February, 1983. 6 Fig, 13 Ref.

Descriptors: *Saline water intrusion, *Groundwater movement, *Coastal aquifers, Model studies, Mathematical models, Saline-freshwater interfaces, Aquifers, Unconfined aquifers, Confined aquifers.

A mathematical model for saline water intrusion describes the salt water-fresh water motion with a sharp interface. It was used to develop a numerical model (finite difference method) which unconditionally convergent and stable. The numerical model was verified by simulating three cases for which analytical results were known. These were: (1) steady state analytical solution (for two cases, confined and unconfined aquifer), (2) unsteady state solution with variable boundary conditions at the coast, and (3) unsteady state analytical solution including only motion of the interface tip and toe. The numerical model and analytical results agreed well for Case (1) and Case (3). In Case (2) agreement was good close to the interface tip and became less favorable toward the interface toe. (Cassar-FRC)
W84-00116

THE WATER-TABLE OF THE RHINE PLAIN IN ALSACE (LA NAPPE PHREATIQUE DE LA PLAINE DU RHIN EN ALSACE),
Strasbourg-1 Univ. (France). Bureau de L'Environnement.
L. Simler.
Techniques et Sciences Municipales, No 2, p 79-88, February, 1981. 17 Fig, 1 Tab.

Descriptors: *Water table fluctuations, *Groundwater pollution, *Groundwater movement, Alluvial plains, Natural water table, Water table profiles, France, Rhine River, Alsace.

The water table of the Rhine Plain in Alsace, France, is contained in a lamellar alluvion system, which fortunately behaves like a large-scale homogeneous medium. Transmissivity depends only on the thickness of the alluvium. Moreover, the effects of the slow circulation of groundwater and of the rapid displacement of water in the fluvial system interfere with the action of the water table. The water table levels are thus autoregulated, especially since the fluvial system is dense. These interference phenomena explain the mechanisms of pollution, and notably of pollution by chlorides, and may be used for determining the speed of pollution removal when pollution sources are eliminated. (Author's abstract)
W84-00314

2G. Water In Soils

SOIL CRUSTING AFFECTS WATER CONSERVATION AND INFILTRATION,
Kansas Water Resources Research Inst., Manhattan.
For primary bibliographic entry see Field 3F.
W84-00167

SIMPLE METHOD FOR PREDICTING DRAINAGE FROM FIELD PLOTS,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
J. Y. Parlange.
Soil Science Society of America Journal, Vol 46, No 4, p 887-888, July-August, 1982. 2 Ref.

Descriptors: *Mathematical equations, *Drainage patterns, *Surface tension, *Diffusion coefficient, *Soil water suction, Model studies, Mathematical models, Drainage, Surface drainage, Prediction, Soil water.

A simple method based on analytical solutions of Sisson et al. (1980) for predicting drainage from field plots is proposed. The work of Sisson and colleagues assumes that gravity is primarily responsible for water movement during drainage and neglects the effects of diffusion. The neglect of surface tension effects may lead to significant errors near the soil surface. In the new equation,

profiles at a given time are translated upwards by gamma cm (treated as a constant), where gamma depends on suction near the surface and the time is adjusted to conserve mass. These corrections bring the analytic and numerical solutions closer together. (Geiger-FRC)
W84-00187

SOIL SOLUTE CONCENTRATION DISTRIBUTIONS FOR SPATIALLY VARYING PORE WATER VELOCITIES AND APPARENT DIFFUSION COEFFICIENTS,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
A. Amoozegar-Fard, D. R. Nielsen, and A. W. Warrick.
Soil Science Society of America Journal, Vol 46, No 1, p 3-9, January-February, 1982. 10 Fig, 1 Tab, 13 Ref.

Descriptors: *Fate of pollutants, *Soil water, *Salts, *Simulation analysis, *Spatial distribution, *Solute transport, *Monte Carlo method, *Interstitial water, Saline water, Mathematical studies, Soil porosity, Porosity, Permeability coefficient.

Knowledge of the movement of salts and other water-carried constituents through soils is important in maintaining productive agriculture and a healthy environment. A Monte Carlo simulation was performed to predict relative solute concentrations and solute movement properties as affected by the variability of pore water velocity (v) and apparent diffusion coefficient (D). Normal distribution of the natural log of v, the natural log of D, and water-filled porosity were used to determine 2,000 values of relative solute concentrations using the solute flow equation with no soil-solute interaction. Both step and pulse inputs of salt water were simulated. For pulse input, both equal depths and equal infiltration time were studied. Results showed sharp differences between the solute profiles when deterministic values of v are used compared to the average salt profile for 2,000 random values of v. The variability of D was also found to be less important than for v, especially for greater depths. For the pulse input, more salt will occur in the upper part of the profile when 7.5 cm of salt water infiltrate at each point in the field than when 7.5 cm is the average infiltration depth for the whole area. (Geiger-FRC)
W84-00188

PIPE DRAINAGE OF HEAVY SOILS: A FIELD EVALUATION,
Soil Conservation Service, Lincoln, NE.
For primary bibliographic entry see Field 4A.
W84-00191

PRODUCTIVITY OF WESTERN LARCH AND SUBSOIL PERCOLATION RATES ON POOR ACIDIC SOILS,
Montana Univ., Missoula. School of Forestry.
C. Spitzner, and N. Stark.
Soil Science, Vol 134, No 6, p 395-400, 1982. 3 Tab, 21 Ref.

Descriptors: *Soil properties, *Productivity, *Drainage, Saline soils, Percolation, Leaching, Nutrients, *Montana, Subsurface water.

A study was conducted to determine whether variation in the subsurface percolation rate of underlying glacial till significantly affects the nutrient content of the andic surface soil or timber production on the andic soils. Twenty sites were sampled during the summer of 1980, covering a range of three percolation classes. All had ash depths of 18 to 50 cm, covering 160 m of elevational range and receiving an average of 950 to 1125 mm precipitation. All sites had western larches about 50 years of age. Analysis of the data and comparison of means for the various nutrient concentrations in the volcanic ash layers of the soil profiles did not show significant differences with changes in subsurface percolation rates, except for phosphate. Comparable leaching of the volcanic ash occurred on all sites, except for phosphate retention by the ash on the slowly drained soils. Ash on the slowly drained sites tended to be lower in most ions than ash on faster draining sites. Soil nutrients were significantly more abundant in the slowly drained sites. Soil nutrients were significantly more abundant in the slowly drained subsoils. Natural variability among site factors and physical differences in the subsoil may have contributed to this finding. Ion movement is likely to be influenced by the abundance of hydrogen ions in these soils. (Baker-FRC)
W84-00193

'BLUE' SOILS CAUSE COMPLEX DRAINAGE PROBLEMS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
B. R. Hanson, and L. D. Whittig.
California Agriculture, Vol 34, No 10, p 13-14, October, 1980. 2 Tab.

Descriptors: *Drainage, *Soil chemistry, *Saturated soils, Soil properties, Iron compounds, Hydraulic conductivity, Blue soils, Compacted soils, Soil compaction, Soil saturation, Soil texture, Anaerobic conditions.

Drainage conditions were investigated in an area with brown top soil underlain by blue, blue-gray, and mottled saturated soils. Although the texture of the soils indicated that water movement was adequate for a drainage system, the hydraulic conductivity in the blue layer was extremely low. This low hydraulic conductivity is believed to be the result of reduced iron and high organic matter content of the soil. Under these conditions ferrous hydroxide is formed and precipitated out of the water, forming a gelatinous substance, which compacts the soil. Drainage to oxidize the iron was impossible in this situation because of poor drainage conditions and frequent wetting by rainfall and irrigation. It was suggested that a shallow drainage system be installed only in the top soil to provide a suitable root zone environment for agricultural purposes. (Cassar-FRC)
W84-00299

SOME EFFECTS OF LINEARIZING THE UNSATURATED SOIL MOISTURE TRANSFER DIFFUSIVITY MODEL,
California Univ., Irvine. School of Engineering.
T. V. Hromadka, and G. L. Guymon.
Water Resources Research, Vol 16, No 4, p 643-650, August, 1980. 15 Fig, 2 Tab, 11 Ref.

Descriptors: *Soil water, *Diffusivity coefficient, *Infiltration, Wetting, Finite element method, Crank-Nicolson Model, Galerkin model, Unsaturated flow, Model studies.

Unsaturated soil moisture transfer in a horizontal column was estimated using the Galerkin method combined with the Crank-Nicolson time advance approximation. The Galerkin technique was used for the quasi-linear spatial discretization problem, and the Crank-Nicolson technique was used with a diffusivity coefficient update method. For the constant diffusivity coefficient problems a modified capacitance matrix scheme significantly improved results over the standard finite element capacitance matrix. Five methods of estimating quasi-constant soil water diffusivity equivalents were evaluated. The resulting moisture content profiles from both the modified and unmodified capacitance matrix formulations were compared with the known Philip's solution for each of the five quasi-constant diffusivity computational schemes. Best results were obtained with the unmodified finite element capacitance matrices based values of diffusivity coefficients evaluated as the mean parabolic value of the state variable (water content). (Cassar-FRC)
W84-00302

2H. Lakes

SENSITIVITY OF OREGON'S CASCADE LAKES TO ACID PRECIPITATION,
Oregon State Univ., Corvallis. Dept. of Civil Engineering.
P. O. Nelson, and G. K. Delwiche.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111780, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Research Institute Publication WRRI-85, Oregon State Univ., Corvallis, September 1983. 55 p, 7 Fig, 3 Tab, 35 Ref, 3 Append. OWRT A-061-ORE(1), 14-34-0001-2139.

Descriptors: *Acid rain, Precipitation, Lakes, Oligotrophic lakes, Lake contamination, Chemical properties, *Carbonates, *Oregon carbon, *Dissolved organic carbon, Dissolved aluminum, *Dilute-lake chemistry, Buffering capacity, *Oregon, Oregon cascades, Oregon lakes, *Oregon cascade lakes.

Susceptibility to acidification and present extent of anthropogenic acidification were studied for 63 Oregon Cascade lakes in 1982. Chemical parameters included pH, conductivity, alkalinity, calcium, magnesium, sodium, potassium, dissolved silica, chloride and sulfate. Major ion balances were calculated. Analyses for total organic carbon, fluoride and aluminum were performed in some cases. The lakes have extremely dilute ionic compositions. Average conductivity was 17.0 umhos/cm. Average laboratory-equilibrated pH was 6.96. Alkalinities averaged 137.6 ueq/l; 25 lakes had alkalinities of less than 50 ueq/l. Calcium was the major cation (36%) and bicarbonate was the major anion (82%) present. Aluminum and sulfate concentrations were extremely low. The carbonate system was found to be the dominant buffer system. Extremely low alumunim and total organic carbon concentrations indicate the minor contribution of aluminum hydrolysis species and weak organic acids to the overall acid neutralizing capacity of these waters. The calcium-to-bicarbonate ratio and the low dissolved aluminum and sulfate concentrations show that anthropogenic acidifications is undetectable to date. Oregon's Cascade lakes do not presently have an acid precipitation problem but are extremely susceptible to acidification. The lakes can serve as a chemical benchmark to compare with acidified lakes of similar volcanic geology.
W84-00038

EFFECT OF LOW PH ON THE CHEMICAL COMPOSITION OF AQUATIC INVERTEBRATES FROM TUNDRA PONDS AT THE SMOKING HILLS, N.W.T., CANADA,
Toronto Univ. (Ontario). Dept. of Botany.
M. Havas, and T. C. Hutchinson.
Canadian Journal of Zoology, Vol 61, No 1, p 241-249, 1983. 6 Fig, 3 Tab, 21 Ref.

Descriptors: *Hydrogen ion concentration, *Acidic water, *Crustaceans, *Aquatic insects, *Tundra, *Alkaline water, Ponds, Chemical properties, Sulfates, Mortality, Daphnia, Sodium, Chlorine, Potassium, Chemical reactions, Aluminum, Northwest Territory.

The effect of low pH due to natural sulfate fumigation on the elemental composition of crustaceans and insect larvae collected from strongly acidic and alkaline tundra ponds at the Smoking Hills, Northwest Territory were examined. Analysis of mortality rates suggested that crustaceans Daphnia middendorffiana, Diaptomus arcticus, Branchinecta paludosa, Lepidurus articus and Diptera Orthocladuis consobrinus were more sensitive to low pH than were insect larvae due to their inability to maintain high internal levels of sodium (Na), Chlorine (Cl), and potassium (K). K levels were also low in dead and moribund Daphnia, but not in the more tolerant Diptera larvae. D. middendorffiana recovered following a brief exposure to pH 4.0 in which Na and Cl concentrations returned to their original levels. Acid-exposed Daphnia became infected by pathogenic fungi. Water chemistry also altered the chemical composition of some of the aquatic invertebrates studied, probably due to the elevated aluminum levels in the acidified pond water. (Geiger-FRC)
W84-00073

EXPERIMENTAL STUDIES ON THE FACTORS LIMITING TROPOCYCLOPS PRASINUS (FISCHER) 1860 IN AN OLIGOTROPHIC LAKE,

British Columbia Univ., Vancouver. Inst. of Animal Resource Ecology.
A. Peacock, and W. J. P. Smyly.
Canadian Journal of Zoology, Vol 61, No 1, p 250-265, 1983. 13 Fig, 10 Tab, 50 Ref.

Descriptors: *Copepods, *Cyclops, *Population dynamics, *Population density, *Oligotrophic lakes, Temporal distribution, Crustaceans, Aquatic populations, Predation, Seasonal variation, Food chains, Mortality, *British Columbia, Placid Lake, Gwendoline Lake.

Factors affecting the relative abundances of Tropocyclops prasinus and Cyclops bicuspidatus thomasi in a small oligotrophic lake (Placid Lake) in coastal British Columbia were examined in laboratory feeding experiments. T. prasinus, which is abundant in the lake, was omnivorous in the later instars but showed no signs of cannibalism or predation on other microcrustaceans. Adult diets of T. prasinus and C.b. thomasi (rate in the lake) did not overlap; however, seasonal abundance peaks revealed a temporal segregation of the anupliar instars of both cyclopoid copepods. Chaoborus flavicans ate more C.b. thomasi than T. prasinus, but in laboratory beakers, in the absence of Chaoborus, C.b. thomasi always outnumbered T. pasinus after 50 or 100 days. Results of large scale exposure experiments showed that lake densities of C.b. thomasi could limit the abundance of T. prasinus in Placid Lake. T. prasinus naupliar mortality was high, even in the absence of C.b. thomasi. In the presence of C.b. thomasi, mortality of nauplius 4 to copepodid I instars was greatly increased. (Geiger-FRC)
W84-00080

THE MACROINVERTEBRATE FAUNAS OF RIFFLES AND POOLS,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
P. Logan, and M. P. Brooker.
Water Research, Vol 17, No 3, p 263-270, March 1983. 2 Fig, 5 Tab, 33 Ref.

Descriptors: *Invertebrates, *Aquatic habitats, *Population density, Macroinvertebrates, Riffles, Pools, Aquatic populations, Aquatic insects, Insects, Stream biota, Classification, Species composition.

Macroinvertebrate population data from 17 studies of rivers (mostly upland) in North America and the United Kingdom were examined for differences in fauna inhabiting pools and riffles. Most of the numbers and taxa were similar in both habitats, but Simulium and Corixa were characteristic of riffles and pools, respectively. Riffles had significantly higher population densities than pools. Generally, Ephemeroptera accounted for a higher proportion of the total density in riffles than in pools. Diptera covered a higher proportion in pools than in riffles. Ephemeroptera represented the only taxa to show significant differences in density between the two habitats, riffles supporting higher densities than pools. The overall ratio for total density (riffles/pools) was 1.1. Only Baetidae and Simuliidae families showed significant differences in density, riffle density being greater than pool density. Results of this study indicated that sites will probably be classified correctly with respect to biological monitoring whether samples are collected in riffles or pools. However, these conclusions should not be applied to lowland rivers, for which insufficient data exist. (Cassar-FRC)
W84-00132

SELF-PURIFICATION OF WATER AS A FUNCTION OF PHYSIOLOGY OF MACROPHYTES,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
K. B. Yakubskiy, and A. I. Merezhko.
Hydrobiological Journal, Vol 18, No 2, p 63-68, 1982. 1 Fig, 2 Tab, 36 Ref.

Descriptors: *Macrophytes, *Water purification, Self-purification, Water quality, Water quality control, Lakes, Reservoirs, Aquatic plants, Pondweed, Reeds, Oxygen, Nutrients, Calcium, Minerals, Potassium, Chlorine, Biomass.

In a body of water, self-purification is closely related to the vital activity of macrophytes and their biological pecularities. Common reed, as a typical representative of subaerial littoral vegetation, exhibits high rates of photosynthesis and active absorption of nitrogen and silicon. It forms a large phytomass, the quantity of which is closely related to the presence of nutrients in the substrate, their absorption, and thus the self-purification of water and high water quality. The phytosynthesis in perfoliate pondweed (submerged vegetation) proceeds at a lower rate, but gas exchange occurs within the water, so that its aeration capacity is higher than that of reed. Pondweed also has high absorption capacity in that it absorbs double the quantity of mineral elements per unit of generated biomass compared to the reed, particularly such elements as potassium, calcium and chlorine. For intelligent use of these macrophytes as biofilters both under natural conditions and in artificial water purifiers, allowance must be made for their biology, particularly their aeration and absorptive capacity. (Baker-FRC)
W84-00144

APPLICABILITY OF CERTAIN COMMON BIOINDICATION METHODS TO EVALUATION OF WATER QUALITY IN THE LITTORAL ZONE OF THE KREMENCHUG RESERVOIR,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 5A.
W84-00146

SELECTIVE FEEDING BY ZOOPLANKTON: IMPLICATIONS FOR LAKE PRODUCTIVITY,
Purdue Univ., Lafayette, IN. Water Resources Research Center.
A. Konopka, K. M. Brown, and C. R. Lovell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113679, Price codes: A07 in paper copy, A01 in microfiche. Technical Report No 161, September 1983. 126 p, 11 Fig, 70 Tab, 76 Ref. OWRT B-127-IND(1), 14-34-0001-1225.

Descriptors: *Bacteria, *Phytoplankton, *Zooplankton, *Primary productivity, Lakes, Photosynthesis, *Food chains, Food webs, *Indiana, Crooked Lake, Little Crooked Lake.

The relationship between phytoplankton, bacteria, and zooplankton activities and distributions was studied in two Indiana lakes: Crooked and Little Crooked. Primary production in the metalimnion was an important source of fixed carbon in these lakes. In Crooked Lake, metalimnetic production accounted for 30-45% of the total production, during the summers of 1979-1981. Changes in the vertical distribution of biomass in the water column had a greater effect upon metalimnetic production than differences in water transparency or incident solar radiation. Excretion of organic carbon by phytoplankton populations is a potentially important source of carbon for heterotrophic bacteria. The photosynthetic rates of water samples were proportional to light intensity and increased from 1.42 to 3.14 mg C mg super -1 chlorophyll a hr super -1 within a range of light intensities from 65 to 150 mu E m super -2 sec super -1. Elevated oxygen concentrations in samples incubated at 150 mu E m super -2 sec super -1 decreased rates of both photosynthesis and excretion. The photosynthetic rate increased from 3.0 to 5.0 mg C mg super -1 chlorophyll a hr super -1 as the pH was raised from 7.5 to 8.8. Calculation of total primary production using a numerical model showed that whereas 225.8 g C m super -2 was photosynthetically fixed during the period between May 12 to August 24, 1982, only g C m super -2 was excreted by phytoplankton. Heterotrophic bacterial activity in the two lakes generally correlated very well with the distribution of phytoplankton. Bacterial activity was primarily associated with planktonic bacteria rather than cells attached to particles. Several zooplankton species found in the lake were capable of ingesting bacteria and unicellular cyanobacteria but could not feed on filamentous cyanobacteria, the most important phytoplankton in the lakes.
W84-00165

REPORT OF THE WORK GROUP ON WETLANDS (INCLUDING RICE) AND AQUATIC SYSTEMS,
K. R. Reddy, V. Montecino, A. J. Holding, U. Irmler, and P. S. C. Rao.
Plant and Soil, Vol 67, No 1-3, p 421-424, 1982. 1 Tab, 5 Ref.

Descriptors: *Wetlands, *Rice, *Nitrogen, Research priorities, *South America, Lakes, Rivers.

A summary report on a wetlands study reveals that the area (in sq km) occupied by various fresh water ecosystems in Latin America is: lakes, 62,000; river basins; 8.1 million; and rice fields, 54,000 (upland) and 21,000 (irrigated). Of the research priorities listed, nitrogen budgets and associated model studies are of primary importance. Using data from the southern U.S., N fluxes were estimated for rice ecosystems in Latin America: influx, 159-325 kg N per ha (largest amounts from fertilizer and soil N mineralization); output, 116-335 kg N per ha (largest amounts from harvest and denitrification). (Cassar-FRC)
W84-00171

THE SPECIES AND SIZE COMPOSITION OF TROPICAL FRESHWATER ZOOPLANKTON WITH SPECIAL REFERENCE TO THE ORIENTAL REGION (SOUTH EAST ASIA),
Waterloo Univ. (Ontario). Dept. of Biology.
C. H. Fernando.
Internationale Revue der Gesamten Hydrobiologie, Vol 65, No 3, p 411-426, 1980. 2 Fig, 6 Tab, 108 Ref.

Descriptors: *Zooplankton, *Lakes, *Species composition, Asia, India, Tropical regions, Temperate zone, Clacoderans, Copepods, Rotifers, Species diversity, Daphna.

The zooplankton population of Southeast Asia (encompassed by India and Nepal in the west, the Philippines in the east, and Indonesia in the south) showed a gradual change from the northern and southern temperate regions to the tropical region. Data was gathered from over 2500 samples collected from 1200 localities during 1968-1977. The number of Cladocera and Copepoda species was much less in the tropical region than in the temperate regions. Daphnia were scarce and small in the tropics and increased in size, number, and diversity toward the temperate zones. This was also true for Holopedidae, Leptodoridae, and Polyphemidae. The littoral zooplankton, Eruycerus and Saycia, were absent or very rare in the tropics compared with the temperate zones. Only two cyclopoids, the herbivorous Thermocyclops crassus and the carnivorous Mesocyclopsleukarti, were common in the tropical region. The most common rotifers were Brachionus and Keratella tropica. Endemic and unexpected Cladocera reported were Alona macronyx Daday, Chydorus faviformis Birge, Alonella nana Baird, and Indialona ganapati Petrovski. (Cassar-FRC)
W84-00296

SEASONAL CYCLES OF ZOOPLANKTON AND RELATED PHYTOPLANKTON DEVELOPMENT IN THREE SHALLOW, MESOTROPHIC LAKES IN NORTHERN CANADA,
Alberta Environmental Center, Vegreville.
J. W. Moore.
Internationale Revue Der Gesamten hydrobiologie, Vol 65, No 3, p 357-378, 1980. 7 Fig, 4 Tab, 49 Ref.

Descriptors: *Zooplankton, *Population density, *Food habits, Lakes, Phytoplankton, Seasonal variation, Mesotrophic lakes, Canada, Temperature effects, Subarctic zone, Grace Lake, Long Lake, Madeline Lake.

The seasonal cycles of zooplankton and phytoplankton development were studied during April 1978 to April 1979 in three shallow, mesotrophic lakes (Grace, Long, and Madeline) in northern Canada. The lakes were similar in nannoplankton density (50-450 mg per cu m in summer), net phytoplankton density (200-1600 mg per cu m in summer), temperature, depth (11-17 m), oxygen

concentration, and phosphorus levels. Most common nannoplankton species were Nannochloris bacillaris, Rhodomonas minuta var. nannoplanktonia, Ochromonas, and other phytoflagellates. Main phytoplankton taxa were Dinobryon and filamentous cyanophytes. The seasonal changes in zooplankton species (Keratella cochlearis, Kellicottia longispina, Polyarthra vulgaris, Polyarthra remata, Cyclops, Diaptomus ashlandi, Daphnia longiremis, and Codonella cratera) were similar in the three lakes. Changes in densities of these species were not statistically correlated with fluctuations in nannoplankton availability, implying that food did not limit development. Although predatory copepods were abundant, they had no measurable impact on the main species. It was concluded that temperature was the most important factor regulating the seasonal cycles and the population sizes of most zooplankton. (Cassar-FRC)
W84-00305

TROPHIC UPSURGE IN NEW RESERVOIRS: A MODEL FOR TOTAL PHOSPHORUS CONCENTRATIONS,
Department of the Environment, Sainte-Foy (Quebec).
Y. Grimard, and H. G. Jones.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 39, No 11, p 1473-1483, 1982. 5 Fig, 1 Tab, 38 Ref.

Descriptors: *Reservoirs, *Phosphorus, Nutrients, Model studies, Trophic level, Canada, Canadian Shield.

A model is presented for total phosphorus concentrations during both the trophic upsurge and depression phases in new reservoirs. The model was developed by a convolution of the rate of phosphorus leaching from flooded lands and the rate of reservoir filling. Model parameters for phosphorus sedimentation and leaching coefficients were estimated from data available on the Smallwood Reservoir (impoundment 1971) in Labrador. The model was then applied to predict phosphorus concentrations during the trophic upsurge phase in the La Grande-2 Reservoir (impoundment 1978) in the James Bay region of Quebec. Because the sparse data available on other new or old reservoirs during the trophic upsurge phase does not permit an analysis of the confidence limits in model output, discussion of the calculated values of model parameters and their relationship to the real phenomena are included. An evaluation of the rates of phosphorus leaching from various lands has shown indirectly that the proposed model approximates the dynamics of new reservoir phosphorus concentrations. It is concluded that the model as defined bears some promise as the base for an empirical model, although compatible data on reservoir systems are rare. Confidence in the model is enhanced, as the values of certain model parameters are of the same order of magnitude as those calculated by independent means. The model has a good potential as an empirical predictive tool in the management of large new reservoirs on the Canadian Shield. (Baker-FRC)
W84-00315

2I. Water In Plants

THE EFFECT OF MOISTURE STRESS ON CORN PRODUCTION IN THE HIGH PLAINS,
New Mexico State Univ., Las Cruces. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W84-00163

SIMULATING PLANT WATER UPTAKE IN MOIST, LIGHTER TEXTURED SOILS,
Georgia Agricultural Experiment Stations, Athens.
E. W. Tollner, and F. J. Molz.
Transactions of the ASAE, Vol 26, No 1, p 87-91, 99, 1983. 5 Fig, 2 Tab, 10 Ref.

Descriptors: *Soil properties, *Soil-water-plant relationships, Model studies, Richard's equation, Mathematical studies, Mathematical equations, Permeability.

Mathematical models for simulating water transport in soils containing roots have been extremely useful for increasing the understanding of soil-water-plant relationships. Such models are currently being used in the design of various water and waste management systems where soils are relatively wet much of the time. Consideration is given to the case of one-dimensional, vertical movement of water in a soil containing the roots of transpiring plants. Mathematical complexity is thus kept to a minimum while the basic physical principles are described. The results can be generalized to multi-dimensional situations. A physically based root extraction relation for use in Richard's equation is proposed. The extraction function assumes that the water uptake rate per unit volume of soil is proportional to the product of contact length per unit soil volume, root permeability per unit length and water potential difference between soil annd root xylem pot volume of soil is proportional to the product of contact length per unittential, which is assumed to be constant over the root zone. Herkelrath's factor, which accounts for reduced root-soil-water contact as water is removed, was included. Thus the model should be applicable in any system involving lighter texture soils kept relatively wet. Model predictions compared favorably with the results of a previously performed experiment. (Baker-FRC)
W84-00181

2J. Erosion and Sedimentation

DENSITY GRADIENT ANAYLSIS OF SUSPENDED MATTER,
California Univ., Davis. Dept. of Land, Air and Water Resources.
A. W. Knight.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111673, Price codes: A03 in paper copy, A01 in microfiche. California Water Resources Center Completion Report, Univ. of California, Davis, October 1983. 33 p, 14 Fig, 3 Tab, 25 Ref. OWRT A-085-CAL(1).

Descriptors: *Centrifugation, Separation techniques, *Sediment sorting, *Estuaries, *Algae, Sediment-water interfaces, Bottom sediments, Sediment concentration, Marine concentration, Suspended concentration, Toxicity.

Development of a simple and inexpensive density gradient centrifugation method, utilizing silica sols, for separating and isolating various fractions of suspended matter and bottom sediments was begun. There is presently no effective means for fractionating suspended material in natural waters into its natural components. The technique will be especially useful for researchers in estuarine productivity and toxicology. The influence of preservatives and density shift reagents on the separating and resolving powers of the centrifugation method has been analyzed. In addition the interaction between the method and the density shift reagents and preservatives on analysis of chlorophyll a, proteins, and carbohydrates was examined. Preliminary results indicate that the development of suitable methodology will require considerable additional effort. The technique has demonstrated that it is an important means of separating certain algal associations. (Snyder-California)
W84-00027

SEDIMENT TRANSPORT BY WAVES AND CURRENTS,
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
M. C. Quick.
Canadian Journal of Civil Engineering, Vol 10, No 1, p 142-149, 1983. 6 Fig, 13 Ref.

Descriptors: *Sediment transport, *Wave action, *Water currents, Laboratory studies,.

The combined action of waves and currents on sediment transport was studied in a laboratory flume with a sand bottom, wave paddle, and current generator. Sediment transport direction was mainly determined by the direction of the wave movement, even in the presence of adverse currents, until waves started to break. Mass transport wave velocity increased in the presence of adverse currents, so that sediment still moved slowly in the direction of wave advance. Waves moving into a region of stronger adverse currents became steeper. When they began to break, the mass transport velocity at the bed fell to zero, and sediment transport then followed the direction of the adverse current. A transport power relationship was developed to predict the sediment transport rate. This agreed with the measured sediment transport rates. (Cassar-FRC)
W84-00069

SEMI-EMPIRICAL CORRELATIONS FOR FINE AND COARSE COHESIONLESS SEDIMENT TRANSPORT,
Lamar Univ., Beaumont, TX.
P. A. Mantz.
Proceedings of the Institution of Civil Engineers. Part 2: Research and Theory, Vol 75, No 1, p 1-33, 1983. 6 Fig, 13 Tab, 28 Ref.

Descriptors: *Bed load, *Sediment load, *Sediment transport, *Theoretical analysis, *Resistance, *Mathematical, Sediment distribution, Streamflow, Suspended load, Shear stress, Flow velocity.

The equilibrium sediment transport, bedform development and hydraulic resistance for three grades of almost equal-sized silica solids were studied under three flow depths and six conditions of average flow velocity. Sediment transport was analyzed according to the streampower theory developed by Bagnold, assuming that the rate of applied flow energy was dissipated partly by the friction of moving bed load solids, partly by the turbulence associated with bedforms, partly by the gravitational settling of suspended load solids, and partly by the friction of the unimpeded flow. Correlations were generated for the work rates associated with the moving bed load or suspended load and the streampower excess, which excludes that required for incipient transport or incipient suspension. Field data were compared with laboratory data, and bed load data were abstracted from a recent collation by Bagnold. Suspended load data were abstracted from river data of the United States Geological Survey. The present research expands the three classes of rivers according to Bagnold to take into account coarse and fine sediments, shallow and deep flows and streams of non-rectangular cross-section or a meandering stream. (Geiger-FRC)
W84-00077

DETERMINATION OF BEDLOAD TRANSPORT USING NATURALLY MAGNETIC TRACERS: FIRST EXPERIENCES AT SQUAW CREEK, GALLATIN COUNTY, MONTANA,
Freie Univ. Berlin (Germany, F.R.). Inst. fuer Physische Geographie.
P. J. Ergenzinger, and S. G. Custer.
Water Resources Research, Vol 19, No 1, p 187-193, February, 1983. 4 Fig, 3 Tab, 12 Ref.

Descriptors: *Sediment transport, *Bed load, *Magnetic studies, Tracers, Squaw Creek, *Montana, Measuring instruments.

A detector which records the movement of naturally magnetic pebbles and cobbles in a stream bed was evaluated in Squaw Creek, Montana, during a 10-year flood in May 1981. Particles over 32 mm in diameter were detectable by the instrument. Correction factors accounting for the 85% of pebbles which were not magnetic, the smaller particles not detected (2/3 of total particles), and width of the creek allowed estimation of the total bedload transport. The bedload accounted for 66% of the total solid material (3400 metric tons) leaving the drainage basin during the flood. The rate of transport of suspended load varied from 200-400 kg per hour at the onset to 146,000 kg per hour at the peak stage. The peak in suspended load corresponded with the peak in water discharge. The rate and timing of bedload transport did not correspond as well to water discharge. (Cassar-FRC)
W84-00084

A DECISION MODEL TO PREDICT SEDIMENT YIELD FROM FOREST PRACTICES,
National Forests in North Carolina, Asheville.
For primary bibliographic entry see Field 4C.
W84-00099

MODELING UPLAND EROSION,
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
R. M. Khanbilvardi, A. S. Rogowski, and A. C. Miller.
Water Resources Bulletin, Vol 19, No 1, p 29-35, February, 1983. 4 Fig, 2 Tab, 24 Ref.

Descriptors: *Model studies, *Erosion, Mathematical equations, Universal soil loss equation, Rills, Interrills, Sediment transport, Sedimentation.

A computer model of soil loss on an upland watershed has been developed from the continuity considerations for sediment transport and from equations describing rill and interrill erosion. The model is based on dividing the upland area into a grid containing rill and interrill zones, on the Universal Soil Loss Equation, and on equations describing detachment and transport capacity of rill flow. The USLE estimates the sediment load from the contributing areas. The location and amount of total erosion and deposition are determined by comparing the transport and detachment capacity of rill flow for specific storms. The model considers the mechanics of the erosion process and can serve as a basis for reservoir and channel design and land use planning. Interception, though neglected in the numerical example presented, is included in the model. (Baker-FRC)
W84-00104

EXTREMAL HYPOTHESES FOR RIVER BEHAVIOR,
Canterbury Univ., Christchurch (New Zealand). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W84-00129

BIOGEOCHEMICAL CYCLING IN AN ORGANIC-RICH COASTAL MARINE BASIN-3. DISSOLVED GAS TRANSPORT IN METHANE-SATURATED SEDIMENTS,
Alaska Univ., Fairbanks. Inst. of Marine Science.
For primary bibliographic entry see Field 2L.
W84-00153

TRANSPORT OF SAND-SIZED SEDIMENT ALONG CROP-ROW FURROWS,
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
L. D. Meyer, B. A. Zuhdi, N. L. Coleman, and S. N. Prasad.
Transactions of the ASAE, Vol 26, No 1, p 106-111, 1983. 1 Fig, 2 Tab, 15 Ref.

Descriptors: *Sediment transport, *Erosion control, Sand, Rainfall-runoff relationships, Sedimentation, Erosion.

Sediment transport capacity was evaluated along simulated crop row furrows as influenced by furrow gradient, flow rate, sediment size and the presence or absence of rainfall. Only sand-sized sediment of single-particle density was studied. Four sand size groups averaged 77, 151, 302, and 603 micrometers for furrow gradients of 0.2, 1.0, 2.5, and 5.0% at flow rates of about 26, 39, 52 and 65 kg/min with and without intense simulated rainfall. Sediment tranport capacity increased rapidly as furrow gradient increased. The capacity was very small at 0.2%, but it became quite large at gradients above 1%. Transport capacity increased as flow rate increased, but the effect was less than that of furrow gradient. Transport capacity generally increased as particle size decreased below 300 micrometers. Rain falling on the furrow flow did not appreciably affect sediment transport for the conditions tested. The mode of sediment transport changed from isolated barchan dunes to transverse bars to streaky sheets of sediment as the furrow gradient increased. Development of the streaky sheet mode of transport was delayed by rainfall, and the change from bars to streaks occurred at about 1% gradient. (Baker-FRC)
W84-00186

A SMALL-SCALE FLOOD PLAIN,
Rhodes Univ., Grahamstown (South Africa). Hydrological Research Unit.
D. A. Hughes, and J. Lewin.
Sedimentology, Vol 29, No 6, p 891-895, 1982. 3 Fig, 1 Tab, 9 Ref.

Descriptors: *Flood plains, *Deposition, *Sediment sorting, *Sedimentation, Deltas, Suspended sediments, Alluvial deposits, Sediment distribution, Sediment transport, Overflow, Levees, Sedimentology, *Wales, River Rheidol.

A miniature flood plain was formed at a gravel extraction and washing plant on the River Rheidol, Wales. Washing water with high concentrations of fine sediment was channeled into a pit producing a small-scale delta, channel, and flood plain system about 9 m wide. The system developed levees, crevasse splays, and flood basins. Overbank sedimentation was dominant. Median sediment size decreased exponentially with distance from the channel center. At a meander bend coarser sediments were deposited on the outside of the bed. Sorting also improved with distance from the channel. The finest sediments were deposited in the stiller and deeper water. Deposits in the flood plain were laminated or very thinly bedded, without cross stratification. This was a result of variations in sediment supply from different gravels and relocation of crevasses and overflows. (Cassar-FRC)
W84-00189

HIGH SEDIMENT YIELDS FROM MAJOR RIVERS OF THE WESTERN SOUTHERN ALPS, NEW ZEALAND (DISCUSSION AND REPLY),
J. Adams, and G. A. Griffiths.
Nature (London), Vol 287, No 5777, p 88-89, September 4, 1980. 10 Ref.

Descriptors: *Erosion rates, *Suspended sediments, *Mathematical studies, Sedimentation, Suspended load, Rivers, *New Zealand, Flow characteristics, Dissolved solids, Bed load, Sediment load.

This response to a previous article by G. A. Griffiths (Nature, Vol. 282, p 61-63, 1979) suggests that Griffiths took too little heed of published data on sediment yields from major rivers of the western Southern Alps in New Zealand and underreported the suspended load data available. Griffiths reported data on suspended sediment yields from fewer rivers than had previously been reported and applied a traditional approach to calculation of suspended loads which had been questioned by the commentator. The commentator and the author used the same data on sediment loads, but reached significantly different estimates of loads in some cases. The author responds that the commentator had made assumptions in earlier studies which were not substantiated and that data which he presented was not always adequately identified. Griffiths charges that Adams did not make good use of his data, that some evaluations of the data were arbitrary, and that the results of the earlier study were not repeatable. (Carroll-FRC)
W84-00190

2K. Chemical Processes

EFFECT OF LOW PH ON THE CHEMICAL COMPOSITION OF AQUATIC INVERTEBRATES FROM TUNDRA PONDS AT THE SMOKING HILLS, N.W.T., CANADA,
Toronto Univ. (Ontario). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W84-00073

CHEMICAL COMPOSITION AND SPATIAL VARIATION OF BULK PRECIPITATION AT A COASTAL PLAIN WATERSHED IN SOUTH CAROLINA,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2B.
W84-00108

MINERAL PRECIPITATION IN NORTH SLOPE RIVER ICINGS,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
D. K. Hall.
Arctic, Vol 33, No 2, p 343-348, June, 1980. 3 Fig, 12 Ref.

Descriptors: *Calcium carbonate, *Groundwater, *Chemistry of precipitation, *Rivers, *Ice formation, Calcium compounds, Chemical properties, Ice, Arctic zone.

Patches of powdered calcium that were found on icings (aufeis) in the Canning and Shaviovik Rivers in northern Alaska suggest that much of the water feeding the aufeis fields comes from depth and has flowed through calcareous bedrock. Aufeis forms in winter at or below the point of groundwater discharge or when river water is forced up through cracks in river ice. Calcium carbonate is excluded during groundwater freezing and accumulates as slush on top of the ice as the aufeis ablates during the melt season. During a July 1978 field study, four patches of calcium carbonate covering about 0.1% of the total area of the Canning River aufeis were observed. If similar percentages of calcium carbonate precipitate were present on other major aufeis fields on the eastern North Slope, about 18000 cu m of calcium carbonate may be present during a given year in these aufeis fields. The majority of this precipitate is deposited into the Arctic Ocean via river flow. (Geiger-FRC)
W84-00301

NITRATE DEPLETION IN A SECOND-ORDER MOUNTAIN STREAM,
Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab.
W. T. Swank, and W. H. Caskey.
Journal of Environmental Quality, Vol 11, No 4, p 581-584, October-December, 1982. 2 Fig, 5 Tab, 20 Ref.

Descriptors: *Denitrification, *Nutrients, *Sediments, Coweeta Hydrological Laboratory, North Carolina, Forest watersheds, Streams, Nitrogen, Logging, Clear-cutting.

Denitrification was studied in Coweeta Hydrological Laboratory, a 2270 ha hardwood forest site in the Appalachian Mountains of North Carolina, for 4 years starting June 1976. During this period logging roads were cut, resulting fills and cuts were stabilized with seeding and liming, and logging was conducted (first half of 1977). Within-stream depletions of nitrate-N from upper to lower reaches of the second-order stream were 127% of total nitrate-N discharged at the outlet the first year, and 99%, 42%, and 5% in succeeding years. Nitrate-N depletion was 3.3 kg the first year, and 27.9, 32.4, and 3.9 kg in succeeding years. Denitrification in the sediment, measured by enzyme assay, produced a loss of 1.7 kg N during the final year of the study. This suggests that sediment denitrification is a major pathway for nitrate-N loss. Neglect of this factor in studies of N dynamics can result in underestimation of N losses in streams. (Cassar-FRC)
W84-00327

2L. Estuaries

DEGRADATION OF ATRAZINE IN ESTUARINE WATER/SEDIMENT SYSTEMS AND SOILS,
Salisbury State Coll., MD.
For primary bibliographic entry see Field 5B.
W84-00018

OLIGOCHAETES AS INDICATORS OF POLLUTION IN THE HUMBER ESTUARY, WITH SPECIAL REFERENCE TO TUBIFICOIDES BENEDENI,

Anglian Water Authority, Huntingdon (England). Lincolnshire River Div.
For primary bibliographic entry see Field 5A.
W84-00025

EFFECTS OF LIGHT, TEMPERATURE AND SALINITY ON THE PHOTOSYNTHETIC PATTERN IN AN ESTUARINE PHYTOPLANKTER FROM CHESAPEAKE BAY,
Agricultural Research Service, Beltsville, MD.
D. E. Terlizzi, and E. P. Karlander.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111871, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Technical Report No 72, Univ. of Maryland, College Park, August 1983. 22 p, 7 Fig, 27 Ref. OWRT A-059-MD(1), 14-34-0001-2122.

Descriptors: Light, Temperature, *Salinity, *Photosynthesis, *Phytoplankton, Interactions, Stress, Protein, Lipid, Polysaccharide, Free metabolites, *Chesapeake Bay, *Maryland.

The effects of the variables; light intensity, temperature, and salinity on the growth rate and the pattern of NaH super 14 CO sub 3 photoassimilation in a coccoid nanoplankter from the Chesapeake Bay (UTEX 1998) were examined. While growth rates were depressed in some instances as a result of a change in medium composition, results generally support earlier conclusions that this organism has a relatively high temperature optimum and favors moderate salinities. Although the response to stress observed by other workers of an enhanced relative incorporation of super 14C into the protein fraction is not always observed, it does occur at 15C and 35 o/oo at all light intensities examined and at 30C under the same light intensities and salinity. In comparing the super 14C fractionation data with growth rate, several trends were observed: (1) Protein super 14C generally increased with increasing growth rate at 15C, (2) Polysaccharide super 14C tended to increase with growth rate at 15 and 30C, but optima at intermediate growth rates were observed at 20C, (3) super 14C incorporation into the lipid fraction decreased with increasing growth rate, (4) Free metabolite super 14C decreased with increasing growth rate except at 20C. The data demonstrate that trends in the photosynthetic pattern as a function of growth rate are regulated by the major physico-chemical parameters of the estuarine environment.
W84-00047

A TWO-DIMENSIONAL NUMERICAL MODEL OF ESTUARINE CIRCULATION USING CUBIC SPLINES,
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
P. Wang, and R. Kahawita.
Canadian Journal of Civil Engineering, Vol 10, No 1, p 116-124, 1983. 10 Fig, 11 Ref.

Descriptors: *Saline water intrusion, *Tidal effects, *Water circulation, Mixing, Estuaries, Spline function, Model studies, Great Whale River, Stratification, *James Bay region.

Velocity and salinity distributions along an estuary have been described by a two-dimensional, laterally integrated numerical model. Governing equations, which express the dynamics of a partially mixed estuary, consist of continuity, momentum balance, and salt and/or heat balance equations, together with an equation of state. They are solved by a finite difference method combined with spline functions. The model was applied to a study of the Great Whale River, James Bay, Canada. The effects of stratification on the salinity distribution were determined. Computed vertical velocity profiles corresponded with the observed dominant upstream current in the lower layers even at ebb tide. At high tide the flow at the river mouth reverses completely. Field data for calibrating this model is not yet available. (Cassar-FRC)
W84-00070

SOME HYDROTECHNICAL PROBLEMS RELATED TO THE CONSTRUCTION OF A CAUSEWAY IN THE ESTUARY OF THE PETITCODIAC RIVER, NEW BRUNSWICK: DISCUSSION,
Northwest Hydraulic Consultants, North Vancouver (British Columbia).
For primary bibliographic entry see Field 6G.
W84-00081

BIOGEOCHEMICAL CYCLING IN AN ORGANIC-RICH COASTAL MARINE BASIN-3. DISSOLVED GAS TRANSPORT IN METHANE-SATURATED SEDIMENTS,
Alaska Univ., Fairbanks. Inst. of Marine Science.
G. W. Kipphut, and C. S. Martens.
Geochimica et Cosmochimica Acta, Vol 46, No 11, p 2049-2060, 1982. 9 Fig, 4 Tab, 36 Ref.

Descriptors: *Seasonal variation, *Nitrogen, *Radon, *Marine sediments, *Radioactive tracers, *Methane, *Ebullition, *Coastal waters, *Argon, Bights, Estuaries, Radioisotopes, Sediment transport, Sediment-water interfaces, Geochemistry, *North Carolina, Cape Lookout Bight.

A seasonal study of the transport processes controlling dissolved gas distributions in the sediment of a small marine basin, Cape Lookout Bight, North Carolina, was conducted to identify seasonally varying mechanisms of dissolved gas sediment-water exchange and to quantify rates of stripping dissolved gases from sediments during ebullition. Results showed that transport of dissolved gases in the anoxic sediments is controlled by diffusion and bubble ebullition and follows a seasonal cycle. Seasonal profiles of methane, nitrogen, argon and radon 222 gases and direct gas flux measurements showed that ebullition dominates the flux of all dissolved gases across the sediment-water interface during the summer months and is important on an annual basis. Transport in the upper 6-8 cm of sediment appears to be controlled by molecular diffusion of gases, while at greater depths it is controlled by diffusion in winter and ebullition in summer. Rates of stripping of dissolved gases within the methane production zone averaged 3-5%/day. Sediments of the bight are never at saturation with respect to the major gases present in seawater due to summer ebullition. Research at other sites suggests that ebullition may be an important transport process in many coastal sediments, and may serve as a mechanism for the transport of volatile reduced compounds between the atmosphere and anoxic sediments. (Geiger-FRC)
W84-00153

SOURCES, SINKS, AND DISTRIBUTION OF ORGANIC CARBON IN THE ST. LAWRENCE ESTUARY, CANADA,
Bedford Inst. of Oceanography, Dartmouth (Nov Scotia). Atlantic Oceanographic Lab.
For primary bibliographic entry see Field 5B.
W84-00155

A NUMERICAL MODEL OF CIRCULATION IN A CONTINENTAL SHELF-SILLED FJORD COUPLED SYSTEM,
Alaska Univ., Fairbanks. Inst. of Marine Science.
H. J. Niebauer.
Estuarine and Coastal Marine Science, Vol 10, No 5, p 507-521, May, 1980. 12 Fig, 26 Ref.

Descriptors: *Model studies, *Numerical analysis, *Fjords, *Subarctic zone, *Water circulation, Mathematical models, Estuaries, Continental shelf, Coriolis force, Water currents, Wind-driven currents, Advection, Alaska.

A cross-sectional numerical model of continental shelf-silled fjord coupled systems was constructed to simulate bottom water renewal processes in silled estuaries. The finite difference, time dependent model is non-linear and includes friction, stratification and topography while assuming no longshore propagation or advection. The model was applied to a high altitude subarctic fjord opening on to the Gulf of Alaska shelf. Modeling experiments on Resurrection Bay suggest that the Coriolis force should be taken into account in studying the bottom water renewal of narrow fjord basins. Coastal upwelling and downwelling on the adjacent shelf greatly affect fjord wide circulation and renewal. These findings suggest that deep-water renewal is almost continuous year round although the driving forces and associated results are strongly seasonal. The model results showed good agreement with hydrographic, meteorological and current data from the Resurrection Bay-continental shelf system.
W84-00298

GROUNDWATER-SOLUTE INFLUX,
Atomic Energy of Canada Ltd., Chalk River (Ontario).
D. R. Lee.
Limnology and Oceanography, Vol 25, No 1, p 183-185, January, 1980. 1 Fig, 19 Ref.

Descriptors: *Solute transport, *Groundwater, Marshes, Salt marshes, Great Sippewissett Marsh, Nutrients, Fluctuations.

Questions are raised concerning a previously published paper (Valiela, I., et al., Nutrient and particulate fluxes in a salt marsh ecosystem: tidal exchanges and inputs by precipitation and groundwater, Limnology and Oceanography, Vol. 23, p 798-812, 1978). According to the present discussion, it seems justifiable to conclude that groundwater may be an important source of nutrients to salt water, but the hydrogeologic features of the specific study area must be given due attention. For example, samples from springs may not be adequate for estimating the quality of groundwater entering a body of surface water. Dramatic variations in discharge from a regional groundwater flow system seem questionable. Estimated groundwater input to Great Sippewissett Marsh may differ from an estimate based on the Darcy equation. In the current study an independent estimate of probable groundwater flow to the marsh was made based on available hydrogeologic information and gave a much lower value, 1,500 cu m per tidal cycle, compared to the estimate of Valiela et al., 6,700 cu m per tidal cycle. Additional estimates of nitrogen loading of groundwaters were also made, and gave far lower nitrogen and salinity values than those in the original paper. (Baker-FRC)
W84-00303

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

FINAL REPORT ON THE TESTING OF THE ABSORPTION FREEZING VAPOR COMPRESSION PILOT PLANT AT THE WRIGHTSVILLE BEACH TEST FACILITY,
North Carolina State Univ. at Raleigh. Water Process Development Lab.
L. Fleming.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110741, Price codes: A06 in paper copy, A01 in microfiche. Final Report, September 30, 1982. 110 p, 15 Fig, 3 Tab, 5 Append. OWRT C-90227-D(NO 9530)(1), 14-34-0001-9530.

Descriptors: *Desalination apparatus, *Seawater, *Heat transfer, *Absorption freezing vapor compression, Energy consumption, Pilot plants, *Desalination plants, *North Carolina, Wrightsville Beach.

The absorption freezing vapor compression (AFVC) pilot plant is a vacuum freezing process which utilizes a concentrated sodium chloride solution to absorb the large volumes of low pressure water vapor produced in the freezer. This vapor is boiled off in a generator and used to melt the ice formed in the freezer. Seawater does not come in contact with any heat transfer surface nor with the refrigerant and therefore no contaminants are introduced into the aqueous system. Other advantages of the process include: low process temperatures, which reduces corrosion; low theoretical

energy requirements; and no need for pre-filtering of the feed water. The design objective of the plant was to demonstrate a specific energy consumption of 50 kWhr per 1000 gallons of product water at a production rate of 25,000 gpd. The pilot plant was started up in the fall of 1979. Steady state operation of the pilot plant was not achieved until November, 1980, when an auxiliary heat rejection compressor was installed. This compressor provided the capability to reject all the waste heat from the process and thus made steady state operation possible. The normal duration of runs was 100 hours. The plant was not capable of unattended operation. The longest period of uninterrupted steady state operation was approximately 48 hours. The maximum steady state open loop production rate achieved was 21,300 gpd on January 7, 1982. The specific energy consumption was 104 kWhr per 1000 gallons of product water for this run. The high rate of energy consumption was due largely to the poor performance of the absorber and generator heat exchangers and the higher than expected heat rejection load. (Moore-SRC)
W84-00001

MECHANISM AND MOLECULAR INTERACTIONS IN THE TRANSPORT OF WATER THROUGH MEMBRANES,
Agricultural Research Service, Albany, CA. Western Regional Research Center
J. R. Scherer, D. P. Malladi, G. F. Bailey, and S. Kint.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110832, Price codes: A05 in paper copy, A01 in microfiche. Completion Report, (1983). 81 p, 42 Fig, 2 Tab, 30 Ref. OWRT C-90297-S(No 9445)(1), 14-34-0001-0445.

Descriptors: *Cellulose acetate membranes, *Pore water, Absorption, Reverse osmosis, Polymers, Hydration, Polyimide membranes, *Desalination, Desalination processes, *Membrane processes.

Changes in waveguide properties of several cellulose acetate membranes and one polyimide membrane were measured as a function of their exposure to varying levels of relative humidity. The volume fraction of water in the films and the occupied pore volumes were determined from refractive index and thickness changes. The dependence of the refractive index on water absorption is related to a competition between two processes: 'pore filling' with no film expansion and 'free expansion' where the film expands to accommodate the added water volume. The hydration properties of these membranes are affected by degree of acetylation, casting temperatures and annealing treatments. Annealing CA398 membranes at 180 degrees C decreases film water concentration by reducing 'free expansion'. Annealed CA398 membranes that were tested in a reverse osmosis cell had high salt rejection compared to unannealed films. The hydration characteristics of a polyimide membrane are compared to cellulose acetate membranes. Raman measurements of unannealed CA and CTA membranes and annealed CA membranes using the waveguide technique showed that OH groups in unannealed polymers are all hydrogen bonded and are highly accessible to absorbed water. The intergrated OH stretching intensity in the region of 3050 to 3800 cm super -1 was found to be linearly dependent on water concentration. Water absorbed in the 'pore filling' stage is weakly hydrogen bonded to C=0 groups in the polymer and water absorbed in the 'free expansion' stage is hydrogen bonded like bulk water at equivalent 90 degrees C. Analysis of the C=0 stretching region indicated that each of the OH groups of a water molecule are H-bonded to a different C=0 group of the polymer in the 'pore filling' stage of absorption.
W84-00010

SECOND TUBINGEN SYMPOSIUM ON SYNTHETIC MEMBRANES IN SCIENCE AND INDUSTRY,
E. Bayer, and H. Strathmann.
In: Desalination, Vol 34, Nos 1/2, p 1-158, July-August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 75 Fig, 24 Tab, 121 Ref.

Descriptors: *Membrane processes, *Membranes, *Desalination, *Desalination apparatus, Desalination plants, Solute transport, *Synthetic membranes.

The main goal of the Symposium was to initiate a dialogue between membranes experts and possible users of synthetic membranes who were not interested in specific problems of membrane preparation techniques or transport phenomena but would like to find out how membranes can be utilized to solve problems in their specific area of interest. The symposium, which was organized by the Department of Organic Chemistry of the University of Tubingen, hosted more than 250 participants from 15 countries. The basis of synthetic membranes and their applications were described in 6 review lectures. In another 40 papers, the various aspects of synthetic membranes were discussed with the main emphasis concentrated on their practical use. With the rapid growth of industrial applications of membranes and membrane processes, a transition took place in the scientific community interested in synthetic membranes. In the early days of membrane research, mainly physical chemists were interested in this field. Today, scientists and engineers from various scientific disciplines are involved in the field of synthetic membranes. Polymer and organic chemists are mainly concerned with preparation of membranes with desired transport properties, physical chemists study these transport properties and develop new methods for their practical utilization, chemical engineers convert laboratory scale operations into efficient industrial processes.
W84-00052

SELECTION OF MICROPOROUS MEMBRANES FOR OPTIMUM SEPARATIONS,
Nuclepore Corp., Pleasanton, CA.
H. W. Ballew, and M. C. Porter.
In: Desalination, Vol 34, Nos 1/2, p 3-10, July - August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 5 Ref.

Descriptors: Separation techniques, Water purification, *Membranes, *Membrane processes, Desalination, *Microfiltration, *Microporous membranes.

There are basically only two types of microporous membranes commercially available; the screen type and the depth type. Each has numerous advantages and disadvantages. The user should carefully consider several characteristics in selecting which of the two types will perform the optimum separation. This paper compares the physical structure, chemical resistance, retention and other performance characteristics of the two types of membranes and summarizes how these differing characteristics may be utilized to maximum advantage in a variety of typical laboratory and industrial microfiltration applications.
W84-00053

LABORATORY EXPERIMENTS WITH HYPERFILTRATION MEMBRANES,
Heidelberg Univ. (Germany, F.R.). Inst. fuer Angewandte Physikalische Chemie.
W. Schneider, and O. Bauer.
In: Desalination, Vol 34, Nos 1/2, p 11-24, July - August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979) 4 Fig, 2 Tab, 6 Ref.

Descriptors: Separation techniques, Water purification, *Membranes, *Membrane processes, Model studies, Desalination, *Hyperfiltration membranes, Reverse osmosis.

The operation properties of hyperfiltration membranes are representable by various model concepts. The different mathematical relationships that are based on the respective models correspond to the known phenomenological ones and are suitable for describing the throughput through these membranes as well as their separation behaviour within a wide range of operation. Since those relationships are of the same analytical type, it is difficult to account for the mode of action of the membrane from these equations. Laboratory tests with RO membranes are reported with the aim of discussing experimental results which are not covered by the mathematical relationships or which deviate from them respectively. An analysis of these results seems to be helpful for extending the knowledge of the hyperfiltration process.
W84-00054

TREATMENT BY REVERSE OSMOSIS OF CERTAIN SOLUTIONS CONTAINING TWO SOLUTES, ONE ORGANIC AND ONE INORGANIC,
New South Wales Univ., Kensington (Australia). School of Chemical Engineering.
M. J. Clinton, and R. T. Fowler.
In: Desalination, Vol 34, Nos 1/2, p 25-34, July-August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979) 3 Fig, 1 Tab, 22 Ref.

Descriptors: Water treatment, Aqueous solutions, Solvation, Membranes, *Membrane processes, *Reverse osmosis, *Solutes, Sodium nitrate, Sodium sulphate, Urea, Glucose, *Solute transport, Desalination, *Electrolyte transport.

Experiments were performed to see whether equations developed to describe the reverse osmosis treatment of single-solute solutions would be applicable when the solutions to be treated contained both an ionic and a non-ionic solute. Four solutes were chosen: sodium nitrate, sodium sulphate, urea and glucose. Corrections to the traditional equations for electrolyte transport through the membrane were found to be necessary. For some of the two-solute solutions, a certain amount of solute-solute coupling was detected but its influence was small.
W84-00055

LOW TEMPERATURES AND DISSOLVED GASES: TWO PROBLEMS IN SUBMARINE SEA WATER DESALINATION,
Technische Univ., Munich (Germany, F.R.). Dept. of Chemical Engineering.
M. Hampe.
In: Desalination, Vol 34, Nos 1/2, p 35-56, July-August 1980 (comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979) 17 Fig, 4 Tab, 6 Ref.

Descriptors: *Membranes, *Membrane processes, Reverse osmosis, Ions, *Desalination, Seawater, Desalination processes, *Submarine desalination, Ionic rejections, Volume fluxes, Gas permeability.

The behavior of four types of reverse osmosis membranes for sea water desalination at temperatures between 0 degrees C and 20 degrees C was investigated. Besides the rejections of the ionic chief constituents of the sea water and the volume fluxes through the membrane, the permeabilities of gases dissolved in sea water, namely nitrogen, oxygen, argon and (total) carbon dioxide were determined. The volume fluxes show a not expected independance on pressure at temperatures near 0 degrees C. A possible explanation is given.
W84-00056

MEMBRANE/WATER DISTRIBUTION AND DIFFUSION OF NICKEL ION IN CELLULOSE ACETATE MEMBRANES,
G. Mossa, R. Passino, and M. Pegoraro.
In: Desalination, Vol 34, Nos 1/2, p 57-68, July-August 1980 (comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 5 Fig, 1 Tab, 12 Ref.

Descriptors: Separation techniques, Aqueous solutions, Membranes, Membrane processes, *Reverse

osmosis, *Cellulose acetate membranes, *Nickel ion, *Ion transport, Ions, Desalination.

In the framework of a study on the removal of metals from aqueous solutions by reverse osmosis, Ni super ++ diffusion and distribution between weakly charged cellulose acetate (CA) dense membranes and aqueous NiSO sub 4 were determined. NiSO sub 4 solutions with concentrations from 0.1 to 0.001 were used. The values of diffusion coefficients were found to be 10 to the minus 13 squ cm/s and practically independent of salt concentration. Distribution coefficient data varied as a function of the external solution concentration, according to Anderson's treatment of electrolyte sorption. The experimental data were in satisfactory agreement with Glueckauf's physical model of distribution, at sufficient high concentrations.
W84-00057

SOLVENT RESISTANT MEMBRANES FROM POLY-(P-PHENYLENE-TEREPHTHALAMIDE),
Forschungsinstitut Berghof G.m.b.H., Tuebingen (Germany, F.R.).
P. Zschocke, and H. Strathmann.
In: Desalination, Vol 34, Nos 1/2, p 69-76, July-August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 2 Fig, 4 Tab, 5 Ref.

Descriptors: Separation techniques, *Membranes, *Membrane processes, Polymers, Desalination, *Ultrafiltration membranes, Poly(p-phenylene-terephthalamide polymer.

A new solvent resistant ultrafiltration membrane has been developed from poly-(p-phenylene-terephthalamide), a polymer available from du Pont. This membrane exhibits a water flux of 4,500 l/m super 2 d with a rejection of cytochrome C in excess of 99% at 5 bars. Fluxes from 1,450 to 13,800 l/m super 2 d are observed for common solvents. The membrane is stable in almost all organic solvents including dimethylsulfoxide, n-methylpyrrolidone, dimethylacetamide and others.
W84-00058

PROPERTIES AND LONG-TERM BEHAVIOR OF ION EXCHANGE MEMBRANES,
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie.
K. Kneifel, and K. Hattenbach.
In: Desalination, Vol 34, Nos 1/2, p 77-96, July-August 1980 (comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 7 Fig, 3 Tab, 12 Ref.

Descriptors: *Membranes, *Membrane processes, *Electrodialysis, Water treatment, Wastes, Desalination, Electrolysis plants, *Ion exchange membranes.

Membrane data available in the literature from data sheets of the membrane manufacturers are difficult to compare due to different and at times ill-defined test conditions. The characteristic properties: permselectivity, electrical resistance, ion exchange capacity, and water content of commercial ion exchange membranes were therefore determined under standardized conditions. To obtain information about the useful lifetime and the range of applicability in electrodialysis plants, the membranes were subjected to several chemical environments both at room temperature and at elevated temperatures for periods up to five years. The results obtained should be helpful in selecting the appropriate membranes for different electrodialysis applications such as water desalting, wastewater treatment, and recycling of chemical process solutions.
W84-00059

MORPHOLOGY OF AROMATIC POLYAMIDE TYPE ASYMMETRIC REVERSE OSMOSIS MEMBRANES,
Academia Sinica, Dalian (China). Dalian Inst. of Chemical Physics.
Chen Jiayan, Bi Shuchun, Zhang Xingda, and Zheng Lingying.
In: Desalination, Vol 34, Nos 1/2, p 97-112, July-August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 19-19, 1979). 8 Fig, 1 Tab, 21 Ref.

Descriptors: *Membranes, *Reverse osmosis, Desalination, *Membrane processes, Membrane morphology, Scanning electron microscope, Transmission electron microscope, Asymmetric membranes, *Aromatic membranes.

The morphology of aromatic polyamide type reverse osmosis membranes has been investigated with the aid of the scanning and transmission electron microscopes (SEM and TEM). The majority of the samples are treated by the method of critical point drying (CPD) and then observed with a SEM. It has been found that in the dense layer of these asymmetric membranes prepared with significant solvent evaporation, there exists a micellar structure, but various types of defects have been observed on the surface of some parts of such membranes. The variation in structure in the cross-section off these membranes due to different membrane materials and preparation techniques was observed. In the membranes we studied, we found the RO performance to be correlated not only with the degree of densification and reliability of the surface layer but also with the structure of the cross-sections. The cross-section structure characteristics of such membranes with higher RO performance are rather different from those reported in the literature on cellulose acetate and Nomex membranes without notable evaporation. The influence of the casting conditions of the membranes on the morphology is discussed preliminarily.
W84-00060

USE OF THIN CHANNEL SYSTEMS FOR ULTRAFILTRATION AND HYPERFILTRATION,
W. Kofod Nielsen, and R. Frik Madsen.
In: Desalination, Vol 34, Nos 1/2, p 113-130, July - August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 13 Fig, 6 Ref.

Descriptors: *Membranes, *Membrane processes, Desalination, *Ultrafiltration membranes, *Hyperfiltration membranes, Polarization, Thin-channel systems.

One of the first systems developed for hyperfiltration in the 1960's was a thin-channel system. In the 1970's, a thin-channel system was developed with short channels which proved to be excellent for hyperfiltration as well as for ultrafiltration. A description of the system is given. Examples of the applications of thin-channel systems for concentration at high viscosities and high dry-substance contents, e.g. in the food industries, are given. The theory of thin-channel systems is briefly described, especially in respect to answering to question why thin-channel systems are especially suited for treatment of highly viscous liquids. Concentration polarization is an important factor in determining capacity and membrane-separation properties. The concentration polarization can be calculated theoretically, but is difficult to measure quantitatively. A description of a thin-channel system is given, in which the membrane surface can be seen visually. In such a system, the concentration polarization can be shown visually, using coloured solutions. In this way, the influence of flow and pressure on the concentration polarization can be shown by photographs of the concentration-polarization profiles. A survey of the thin-channel systems on the market today is given.
W84-00061

ULTRAFILTRATION PROCESSES FOR POLLUTION CONTROL AND CHEMICAL REUSE IN THE TANNING INDUSTRY,
Naples Univ. (Italy). Facolta di Ingegneria.
E. Drioli, and B. Cortese.
In: Desalination, Vol 34, Nos 1/2, p 131-140, July - August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 3 Fig, 5 Tab, 3 Ref.

Descriptors: Separation techniques, Water treatment, Emulsions, Membranes, *Membrane processes, Water purification, Waste disposal, Desalination, Industrial wastes, *Ultrafiltration membranes, Streams recycle, *Tanning industry wastes.

The new regulations which are in force today require that tanning plants study and implement new technique to reduce pollution at costs which are not prohibitive to the economic continuation of the basic tanning process. In this paper, are presented results obtained in ultrafiltration experiments upon two of the most polluting process streams which leave the tannery: the dehairing and the decreasing waste. These results clearly indicate the possibility of solving large part of the pollution problems with ultrafiltration processes and streams recycle.
W84-00062

THE INFLUENCE OF THE POROUS SUBLAYER ON THE SALT REJECTION AND REFLECTION COEFFICIENT OF ASYMMETRIC CA MEMBRANES,
Technical Univ. of Denmark, Lyngby. Inst. for Kemindustri.
G. Jonsson.
In: Desalination, Vol 34, Nos 1/2, p 141-158, July - August, 1980 (Comprising papers on desalination of the Proceedings of the Second Symposium on Synthetic Membranes in Science and Industry, Tubingen, September 17-19, 1979). 10 Fig, 3 Tab, 23 Ref.

Descriptors: *Membranes, *Membrane processes, Reverse osmosis, Desalination, *Cellulose acetate membranes, Salt rejection, Reflection coefficient.

A relation between the reflection coefficient of the membrane skin, sigma sub alpha, and the overall reflection coefficient for an asymmetric membrane, sigma, has been derived. It is shown that the solute permeability for the skin layer, omega sub alpha, and for the porous sublayer, omega sub b, can be estimated from two sets of reverse osmosis experiments. The ratio omega sub alpha to omega sub b varies greatly with the selectivity of the membrane giving a non-linear relation between omega and omega sub alpha. However, the limiting retention, R super (max) and omega sub alpha seem to be fairly equal independent of the pressure level, thus confirming the theoretically derived relation R super (max)= omega sub alpha.
W84-00063

HYDRODYNAMICS AND HEAT EXCHANGE DURING FILM EVAPORATION OF SEA WATER IN A VAPOUR-WATER UPFLOW,
Dalnevostochnyi Politekhnicheskii Inst., Vladivostok (USSR).
V. Slesarenko.
Desalination, Vol 33, No 3, p 251-258, June, 1980. 4 Fig, 4 Ref.

Descriptors: Desalination, *Desalination processes, *Distillation, Hydrodynamics, *Heat exchange, Seawater, Film evaporation, Vapor-water upflow.

On the basis of experimental research some features of heat exchange during sea water boiling under two-factor system of intensification of the process obtained by means of inclination of the heating surface and application of external vibrating and disturbing actions have been established. Experiments showed that under the above conditions the heat transfer coefficient is 25 - 30% higher than that of a horizontal surface. Some equations have been obtained and experimental data have been summarized.
W84-00064

RAYLEIGH-JEFFREYS STABILITY OF THERMOHALINE STRATIFIED FLUIDS SUBJECT TO HORIZONTAL FLOWS,

Technion - Israel Inst. of Tech., Haifa. Energy Lab.
D. Pneuli, and Y. Zvirin.
Desalination, Vol 33, No 2, p 163-184, May, 1980. 2 Fig, 35 Ref.

Descriptors: Desalination, *Desalination processes, Solar ponds, Horizontal flow, *Rayleigh-Jeffreys stability, *Stratified fluids.

The stability of a horizontal layer of a fluid with density stratification due to both temperature and solute gradients, subject to horizontal flow, is studied for different sets of homogeneous boundary conditions. Sufficient conditions for stability, i.e., the maintenance of the original stratification are obtained as the relation between the thermal Rayleigh number, RaT, and the solute Rayleigh number, RaS. A sufficient condition for stability is obtained for all sets of boundary conditions, where PrT and PrS are the thermal and the solute Prandtl numbers, respectively. This condition is, therefore, also applicable in cases where the physical boundary conditions are not well defined, e.g., in practical engineering use of solar ponds.
W84-00065

ELECTRODIALYSIS IN THE REGENERATION OF PAPER MILL SPENT LIQUOR,
Indian Inst. of Tech., Bombay. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W84-00066

SOLAR OPERATED, MULTIFLASH DISTILLATION,
Scientific Research Foundation, Jerusalem (Israel).
H. Z. Tabor.
Desalination, Vol 33, No 2, p 221-224, May, 1980. 1 Fig, 4 Ref.

Descriptors: Desalination, *Desalination processes, *Distillation, *Solar operated flash distillation, Multi-stage flash distillation.

The proposal by Gasparini et al of desalination units coupled to solar collectors is criticized. The author shows that the paper contains a number of errors which invalidate its conclusions. There is an apparent confusion of average efficiencies, of mean solar radiation for a heliostatically mounted collector with that for a stationary collector. Also the economic calculations are of little value.
W84-00067

COMMENT ON 'SIGNIFICANT DEVELOPMENTS IN MEMBRANE DESALINATION - 1979',
Yorkshire Imperial Metals Ltd., Leeds (England). Research and Development Dept.
K. Hill.
Desalination, Vol 33, No 2, p 225, May, 1980.

Descriptors: Desalination, *Desalination processes, *Reverse osmosis, Seawater, Membranes, *Membrane processes.

In this letter to the Editor, the paper by M. Mattson (Desalination 28(1979)207-224) is lacking comment on the high dissolved solids contents cited with regard to the product water from reverse osmosis treatment of seawater.
W84-00068

TRANSIENT KINETICS OF PROCESSES AT MEMBRANE/SOLUTION INTERFACES,
California Univ., Berkeley. Water Thermal and Chemical Technology Center.
C. C. Herrmann, J. Sinkovic, and T. Vermeulen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113620, Price codes: A05 in paper copy, A01 in microfiche. Completion Report, June 1983. 72 p, 28 Fig, 24 Ref, 3 Append. OWRT C-90015-S(9409)(1), 14-34-0001-9409.

Descriptors: *Electrodialysis, *Electrical impedance, *Fouling, *Membrane, *Polarization, Cleaning, *Desalination, Hyperfiltration, Reverse osmosis.

Electrical impedances of anion-exchange and cation-exchange membranes have been measured in sodium chloride electrolytes under conditions appropriate to desalination by electrodailysis. Alternating-current and Laplace-transformed-pulse methods were used. Results are reported for several membranes under normal desalting current densities, and at high densities causing acid-base formation, with and without presence of a fouling layer. Impedance maxima were found at limiting currents. Under conditions causing substantial concentration-polarization at the membrane diluate interface, a large difference in impedance with measurement frequency was found. Fouling increased low-frequency (diffusion) impedance more than high frequency (resistive) impedance. Measured at 100 Hz, the impedance across an anion-exchange membrane increased substantially at current densities sufficient to cause serious concentration polarization. Measured at 10 KHz very little increase was found. As with the anion-exchange membrane, the impedance at 100 Hz across a cation-exchange membrane increased substantially at current densities sufficient to cause concentration-polarization. However, in contrast with the anion-exchange membrane, the impedance at 10 kHz increased also. The increase of impedance on fouling (with ferric hydroxide) of the cation-exchange membrane was greater.
W84-00160

RESEARCH ON FEASIBILITY OF THIN-FILM COMPOSITE MEMBRANES IN PLATE AND FRAME DEVICES FOR REVERSE OSMOSIS,
FilmTec Corp., Minneapolis, MN.
R. J. Petersen, R. H. Forester, and C. F. Thompson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113703, Price codes: A04 in paper copy, A01 in microfiche. Completion Report, August 1983. 63 p, 15 Fig, 4 Tab, 9 Ref, 1 Append. OWRT C-00196-D(1), 14-34-0001-1407.

Descriptors: *Reverse osmosis, *Economic feasibility, Water treatment, Membrane fouling, *Composite membranes, Plate and frame device, Mississippi River, Minnesota.

The technical and economic feasibility of using plate and frame reverse osmosis systems for low pressure brackish water conversion in conjunction with thin-film composite membranes was investigated. Comparisons were made of membrane fouling rates on Mississippi River water using both FT-30 spiral wound membrane elements and a commercial plate and frame device loaded with FilmTec FT-30 membranes. Both membrane systems exhibited rapid fouling rates at recovery ratios of 50% and higher when run on sand-filtered, pH-adjusted river water. Both membrane systems exhibited approximately the same rates of membrane flux decline due to fouling when examined at comparable recovery rates. The plate and frame system, however, could be restored to its initial flux levels by cleaning treatments, while this was not true for the spiral would elements. For feedwater sources not containing colloidal suspended solids, plate and frame systems were concluded to be economically not feasible based on current cost data. If, however, the feedwater source contained colloidal suspended solids and was known to foul reverse osmosis membranes, certain scenarios favored large plate and frame systems.
W84-00168

PROCEEDINGS OF THE INTERNATIONAL CONGRESS ON DESALINATION AND WATER REUSE, MANAMA, BAHRAIN, NOV. 29-DEC. 3, 1981.
Fairleigh Dickinson Univ., Teaneck, NJ.
Desalination, Vol 38, Nos 1/2/3, November 1981, p 1-588, M. Balaban, R. Bakish, editors.

Descriptors: *Desalination, Desalination plants, *Distillation, Reverse osmosis, Electrodialysis, Solar distillation, Pretreatment of water, Scaling, Materials engineering.

First volume of these Proceedings of the international congress on desalination with the participation of scientists and engineers in the field. This volume contains 58 papers on Thermal Processes, Scale Control, Materials, Membranes - Reverse Osmosis (Fundamentals, Pretreatment, Seawater RO), Membranes - Electrodialysis. (Volume 39 of Desalination constitutes the second volume of the Proceedings).
W84-00203

VAPOR COMPRESSION DISTILLATION WITH MAXIMUM USE OF WASTE HEAT,
Ebasco Services, Inc., New York.
S. J. Senatore.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 3-12, 3 Fig, 6 Ref. (1st Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination process, *Distillation, Vapour compression distillation, Waste heat.

The vapor compression distillation process can be designed as a low capital cost and corresponding low performance ratio (about 7 lbs product per KBtu) or as a higher capital cost and higher PR (about 31) plant. The low PR plant is designed with a maximum brine temperature of about 130F requiring only a polyelectrolyte scale inhibitor. This design would employ a centrifugal compressor that has a pressure ratio of about 1.2. The high PR plant design, which is the subject of this paper, operates at maximum brine temperature of 250F and uses a higher pressure ratio of 1.58. Use of waste heat will be stressed. Either the high or low PR VC process is extremely versatile in application, since it is well adapted to either a dual purpose (power and water) or a single purpose (water only) plant. The high PR that is easily attainable in this design is becoming increasingly more attractive, from an economic view, as the price of fuel continues to escalate. For example, at $5.00/MBTU the fuel contribution to the total cost of water is $5.20/Kgal at a PR of 8 and is reduced to about $1.34/Kgal at a PR of 31. The design and process descriptions for a 2.35 mgd plant will be presented. This plant employs a 65,000 CFM centrifugal compressor. The compressor is driven by a diesel engine and operates across a 4 effect vertical tube foam evaporator. An updated plant cost estimate will be presented and cost of product water.
W84-00204

AN ADVANCED BARGE MOUNTED VTE/VC FOR THE DESALINATION OF SEAWATER,
Envirogenics Systems Co., El Monte, CA.
D. K. Emmermann.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 13-20, 4 Fig, 2 Ref. (1st Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3 1981).

Descriptors: *Desalination, *Distillation, Seawater, Vertical tube evaporator, Vapour compression distillation.

An advanced VTE/VC seawater desalination plant is described. It is a barge-mounted, selfcontained demonstration plant with a rated freshwater output of 5,000/cu m per day and a performance ratio of 30:1 which includes the plant's electrical consumption. Included is a process description of a 24 effect VTE unit with a steam turbine driven compressor and generator combined with two topping effects. Additional features incorporated on the barge include foamy upflow evaporation, ion exchange for seawater pretreatment as well as provision for acid or polymer dosing, and the capability of operation up to a maximum brine temperature of 150C. Test and operational data are presented.
W84-00205

INDUSTRIAL OPERATING EXPERIENCE OF MORE THAN THREE YEARS WITH A 1440 M SUPER 3/DAY SNAMPROGETTI VTE,
Snam Progetti S.p.A., Milan (Italy).
P. Tiraboschi.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 21-28, 4 Fig, 2 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination processes, Multistage flash distillation, *Acids, *Pretreatment of water.

The new desalination process developed by Snamprogetti is discussed and the experiences gained in over 3 years of industrial run is discussed. For two and a half years the plant was fed with acid treated sea water, while in October 1980 it was decided that a high temperature inhibitor, namely Nalco D-4221, should be used. This modification had been envisaged since the beginning as a possibility which, within the programme of research on the desalination unit, could provide an alternative to the acid treatment. The results achieved in over 6 months of this new treatment are good, despite a slight reduction in the thermal exchange coefficients as compared with the results of the acid treatment. An examination of the production diagram shows the good reliability and consequent on stream factor of 94%, which is considerably higher if compared with the 70% of an average MSF plants.
W84-00206

PROCESS SELECTION GUIDE TO SEAWATER DESALTING,
Aqua-Chem, Inc., Milwaukee, WI.
D. R. Finnegan, and W. M. Wagner.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 29-48, 9 Tab, 5 Ref, 6 Fig. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3,1981).

Descriptors: *Desalination, Desalination plants, Distillation, Reverse osmosis.

As desalting technology advances, old processes change and new ones are developed. The current commercial seawater desalting processes including mechanical vapor compression (MVC), thermocompression (TC), multiple effect (ME), once-through multistage flash (MSF-OT), brine recirculation multistage flash (MSF-BR), and reverse osmosis (RO) are compared. These processes are compared on the basis of maintenance and operating complexicity and capital and operating costs. The goal of the paper is to help users and planners answer the question, 'What process is best for me.' Although some of the comments are applicable to all size plants, they are directed primarily to plants less than 2,000,000 GPD capacity. Plants using a combination of processes or hybrid systems are not considered.
W84-00207

COMPARISON OF MSF HEAT REJECTION SECTIONS AND SEAWATER COOLED POWER STATION CONDENSERS,
Watson Desalination Consultants, Manassas, VA.
B. M. Watson, and K. Eimer.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 49-56, 2 Fig., 20 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination processes, Distillation, Multistage flash distillation, *Evaporators, *Condensers, Cooled power station condenser.

A comparison of seawater cooled power station condensers and the heat rejection sections of multistage flash evaporators (MSF) showed very similar design and operational parameters. Remarkable differences are to be seen with regard to the design fouling factor. Typical design fouling factors of MSF rejection sections are about 7 times higher than with a power station condenser. This will result in a heat exchange surface of the rejection section, which is about 50% to 70% larger than with P.S. consensers and will subsequently cause higher capital costs. Design fouling factors much lower than the ones used up to now are recommended.
W84-00208

ADVANTAGES OF THE EJECTOCOMPRESSION PROCESS IN SEA WATER DESALINATION,
Societe Internationale de Dessalement, Paris (France).
M. Lucas, and S. Hessemans.
In: (1st. Volume of the Proc. ofthe Intern. Congress on Desalination and Water Reuse, Bahrain, Nov 29-Dec 3, 1981) Desalination, Vol 38, Nos 1/2/3, November 1981, p 57-63, 2 Fig, 2 Tab.

Descriptors: *Desalination, Desalination process, *Distillation, Multistage flash distillation, Ejectocompression.

The various techniques were developed by SIDEM for seawater desalination. Among those techniques the vapour compression process by ejectocompression is discussed. The ejectocompression process has allowed SIDEM to construct packaged type units with rising maximum capacities: 600 cu m/d in 1979, 1,500 cu m/d in 1980, 2,600 cu m/d in 1981. The main characteristics of 1,500 and 2,600 cu m/d units are given and their operating experience of this type of plants are reviewed. Multiflash units of same capacity are compared in terms of investment costs as well as compactness reliability.
W84-00209

THE EFFECT OF AIR ON CONDENSATION ON A ROPED TUBE,
Glasgow Univ. (Scotland).
J. Cunningham, and A. Holmes.
In: Desalination, Vol 38, nos 1/2/3, November 1981, p 65-74, 5 Fig, 2 Tab, 6 Ref. (1st. Vol of Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Distillation, *Heat transfer surfaces, Roped tubes, Plain tubes, *Tubes.

With an increasing interest in the use of enhanced heat transfer surfaces being shown in connection with desalination, experiments have been carried out to compare the effect on different tubes of noncondensable gases. The tests were made on two roped and one plain tube, each tube having a nominal length and inside diameter of 690 mm and 11 mm respectively. Cooling water velocities ranged from 0.8 m/s to 4.2 m/s and bulk air concentrations at inlet of up to 4.25% by weight were investigated. Although the effect of air on the condensation process was greater on the roped tubes at low cooling water velocities, at the velocities commonly associated with desalination plants there was little difference between the effect of noncondensables on roped and plain tubes. This type of fouling is no worse on roped tubes compared to plain tubes.
W84-00210

DESALINATION BY VAPOR COMPRESSION,
Maschinenfabrik Augsburg-Nuernberg A.G., Munich (Germany, F.R.). Abt. Neue Technologie.
W. Bulang.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, 10 Figs. p 85-97 (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Distillation, Vapor compression distillation.

Description of a newly developed desalination plant system is given. The advantages of the new system are mainly: low operating costs, simplicity of the monostage integrated design, and moderate operation temperatures resulting in negligible corrosion and scaling. A high speed high efficient vapor compressor with high volumetric flow is integrated to the vaporator tank. Horizontal heat exchanger bundles with high heat transfer coefficient self-cleaning low erosion film flow are suspended in a cylindrical evaporator tank. Results of operation under various process parameters are presented.
W84-00211

THE EFFICIENT PRODUCTION OF ELECTRICITY AND WATER IN COGENERATION SYSTEMS,
Bechtel Power Corp., San Francisco, CA.
S. K. Tadros.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, 3 Figs, 1 Tab, 6 Ref. p 99-108 (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Distillation, Electric power, Multistage flash, Steam turbine, Cogeneration systems, Power to water ratio.

Two topping cycle steam turbine cogeneration systems are discussed that can be used to simultaneously produce electricity and water. The water desalination plant selected for detailed comparison is the well-known multistage flash (MSF) evaporator cycle which uses brine recirculation and high temperature additives for scale protection at 233F maximum brine temperature. The impact is discussed of expected future fuel prices on the design of the cogeneration systems under consideration and factors which would further improve the thermal efficiency of both power and desalination plants. The fuel chargeable to power (FCP) is determined in two cases: Backpressure turbine/multistage flash scheme and Extraction turbine/multistage flash scheme. The relation between the cogeneration index in kWh per million Btu to the process, steam turbine backpressure, and power to water ratio are discussed.
W84-00212

CENTRIFUGAL PUMPS FOR DESALINATION,
Ingersoll-Rand Co., Phillipsburg, NJ.
F. F. Antunes, R. E. Cornman, and R. J. Hartkopf.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, 4 Figs., 7 Ref. p 109-122 (1st. Vol of the Proc. of the Intern. Congress on Desalination and Wate Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination apparatus, Centrifugal pumps, *Pumps, Brines.

Centrifugal pumps used for desalination require more stringent material selections and different design considerations than normal applications. The liquid being pumped can be seawater, brackish water, or a concentrated brine. The longevity of the pumps in service depend on their design and the materials used as well as the operating conditions present. Four different pumps related to desalination are discussed. These include vertical wet pit intake pumps, reverse osmosis horizontal multistage charge (injection) pumps, vertical can brine recycle pumps, and horizontal pipeline transfer pumps.
W84-00213

REVERSE RUNNING CENTRIFUGAL PUMPS AS HYDRAULIC POWER RECOVERY TURBINES FOR SEAWATER REVERSE OSMOSIS SYSTEMS,
W. A. Raja, and R. W. Piazza.
In: (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981) Desalination, Vol 38, Nos 1/2/3, November, 1981. 8 Figs. p 123-134.

Descriptors: *Desalination, Desalination apparatus, Pumps, Seawater, *Reverse osmosis, Hydraulic power, Recovery turbines.

The application is discussed of reverse running centrifugal pumps as power recovery turbines to recover up to 80% of that energy. The economics of Hydraulic Power Recovery Turbine (HPRT) systems are explored with respect to the equipment cost, operating costs and payouts for the different sizes of RO systems. HPRT's come in various sizes, types and configurations with efficiencies being a function of specific design, flow rate, pressure and speed. Typical design features of HPRT's are described for use in RO system. Different schemes and equipment arrangements are available and require the use of steam turbines, motors, electric generators, clutches, and speed controls or a combination of the above for optimum results. Recommendation of the most economical equipment arrangement for the RO system is discussed.
W84-00214

DESIGN OF HIGH EFFICIENCY SINGLE AND DUAL PURPOSE PLANTS WITH GAS TURBINES,
G. F. Tusel, and I. Kamal.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 135-144, 8 Figs. (1st. Vol of Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Distillation, Multistage flash, Vertical tube foam evaporation, Reverse osmosis, Gas Turbines, Middle East.

Three basic sizes of gas turbines were considered (30.6, 79.4 and 208 MWe output at ISO conditions). Four different processes were considered for the desalination plants: multistage flash (MSF), vertical tube foam evaporation (VTFE), combined vertical tube foam evaporation-vapor compression (VTFE/VC) and reverse osmosis (RO).
W84-00215

MEDA - A NEW THERMAL CONCEPT FOR DESALTING PLANTS,
G. F. Tusel, B. Ohlemann, D. K. Emmermann, and I. Kamal.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 147 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: Desalination, Desalination plants, *Seawater distillation, VTFE, Vapor compression multistage flash distillation, *Distillation, MEDA project(barge mounted).

The MEDA project comprises a highly efficient, self-contained, VTFE-VC-MSF seawater distillation plant with a capacity of 5000 tons of fresh water per day at a fuel-use performance ratio of 11.8 kg/1000 kJ heat content of fuel. To demonstrate advanced desalting technology with a plant of sufficient capacity in various parts of the world under varying seawater and climatic conditions, MEDA is barge-mounted. Advanced features installed on the barge are: continuous ion exchange pretreatment for removal of calcium and regeneration by brine-blowdown, high heat-transfer rates due to enhanced tubing and foamy up-flow, spirally-indented horizontal tubes in the MSF section, surfactant recovery, turbine driven steam compressor with topping effects, and reverse osmosis system with polishing unit for providing boiler make-up fo: plant start-up. The calcium removal by ion-excnange permits plant operation with a maximum brine temperature of 150C. Product is redistilled in the MSF cooler to produce high purity distillate for desuperheater injection water and boiler make-up.
W84-00216

PERFORMANCE TESTS ON A VERTICAL TUBE EVAPORATION,
Fachhochschule Cologne (Germany, F.R.).
B. Kunst.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 149 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Vertical tube evaporator, *Distillation, Foaming agents.

A two-effect evaporator with a rated capacity of 10,000 l/d has been designed for measuring heat transfer coefficients, pressure drops, entrainment rates and scaling behavior in upflow and downflow VTE. The evaporator is in a closed loop system. The temperature operating range extends from 45 to 145C. Foaming agent added to the sea-water is continuously recovered from the blow down in an extraction column. The performance of the two VTE effects is measured in dependence of temperature, brine flow, salt and foaming agent content.
W84-00217

IN SITU CORROSION STUDY OF STAINLESS STEELS IN AN MSF DESALTING PLANT,
Uddeholms A.B. Degerfors Jarnverk (Sweden).
S. Nordin.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 151 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Corrosion, Multistage flash distillation, Stainless steel.

The corrosion resistance of different stainless steel grades have been studied as regards localized attack under service conditions. Test racks with welded samples with artifically applied crevices were inserted in three different flash chambers. Materials used for splash plates, brine piping, and condensor tubes were also tested. Being a pilot plant, various process conditions were tested. Hence, the materials have been exposed to different corrosive conditions, including stagnant seawater during shut-down periods. Stainless steels of type 316L and higher alloyed exhibit good corrosion resistance, even in brine at high temperature via pipes from the brine heater.
W84-00218

A TUBELESS EVAPORATOR,
Schroeder Process Corp., Santa Ana, CA.
D. W. Schroeder, and P. J. Schroeder.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 155 (Abstract only)(1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Direct contact evaporation, Tubeless evaporator.

A direct contact evaporation process was developed for desalination and waste concentration which can include by-products recovery. The process uses a working substance (WS), such as a high melting organic compound, at its freezing point, to effect the direct contact evaporation. An acceptable WS must be insoluble in water, inert and easily separated by specific gravity difference from brine, product water, and any solids produced. It is also desirable that they be non toxic, non flammable, cheap, and have a high heat of fusion. Several WS's were identified with potential to be used in a commercial plant. A WS screening program tested melting range, solubility, tendency to entrain or emulsify, and stability, in a laboratory program. The bench-scale-plant program simulated the operation of major pieces of equipment with WSs that passed the screening program, and seawater and other saline waters.
W84-00219

FOAM CONTROL ADDITIVES IN MSF DESALINATION,
Pfizer Central Research, Groton, CT.
M. H. Auerbach, J. J. O'Neill, R. A. Reimer, and S. W. Walinsky.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 159-168, 5 Figs, 2,Tab, 26 Ref.

Descriptors: *Desalination, Desalination plants, *Multistage flash distillation, *Foam control additives, Polyglycol monoalkyl ethers, FLOCON anti-foam AF-4.

Excessive foaming in multistage flash desalination plants can give rise to salt contaminated distillate and reduced operating efficiency. Plant operating variations in pressure, temperature, flow and seawater feed composition and alkalinity can perturb vapor/liquid equilibria, resulting in increased levels of foam. Since such foaming is not always controlled by mechanical means, additives are often needed to control foaming level. In additing to controlling foam, a useful additive must not interfere with heat transfer or with the performance of the scale control additive; it must not contain steam-volatile components that can contaminate the distillate; it must be stable at KSF operating temperatures and residence times; and it should be compatible with the antiscalant feed solution. Antifoam performance data for over 60 candidates in 7 chemical classes were determined according to these criteria. The most effective structural class was found to be the polyglycol monoalkyl ethers. Foam control effectiveness within this class was shown to be a function of ethylene oxide content and alkyl chain length. The most effective additive found is offered commercially as FLOCON Antifoam AF-4. FLOCON AF-4 has been used successfully in high-temperature MSF plants.
W84-00220

CALCIUM SULPHATE SCALE REMOVAL DURING OPERATION IN HORIZONTAL TUBE FILM EVAPORATORS,
Hamon-Sobelco, Brussels (Belgium).
For primary bibliographic entry see Field 8G.
W84-00221

FACTORS AFFECTING THE BRINE SCALING POTENTIAL IN MSF PLANTS,
Albright and Wilson Ltd., Oldbury (England).
For primary bibliographic entry see Field 8G.
W84-00222

TARANTO DESALINATION PLANT: A COMPARISON BETWEEN THEORETICAL AND ACTUAL PH VALUES IN A CORRECT DESIGN ACID TREATMENT PLANT,
Italimpianti S.p.A., Genoa.
S. Arazzini, R. Borsani, G. Migliorini, and P. Bozzini.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 185-199, 6 Fig, 1 Tab, 10 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Distillation, *Hydrogen ion concentration, *Italy, Taranto, Acid treatment plant.

The problem of increasing reliability of acid treatment plants was tackled by ITALIMPIANTI with satisfactory results in 3 steps: (1) Theoretical calculation on pH optimum optimum distribution through the plant, adopting the accepted theory of CO sub 2 hydrolysis and HCO sub 3 equilibria in sea water. Also practical values in the Debye-Huckel equation are used in worked examples. (2) By correct positioning of chemical injection points and pH meters arrangement. (3) By correct sizing of decarbonating tower and degasifier which play a key rule in the success of acid treatment. This philosophy was applied in the 5th desalination plant which ITALIMPIANTI designed, built and put into operation in April 1980 for ITALSIDER at TARANTO Steel Works. Correct design enabled achievement of contract performance guarantees. A brief description of the technical features of the plant, the main parameters and the guide concepts of an easy acid treatment design are reported together with the same operational data collected during last year showing the stability and reliability of the system.
W84-00223

ENERGY CONSUMPTION AND OPERATIONAL ASPECTS OF ON LOAD BALL CLEANING SYSTEMS,
K. Eimer.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 201 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Distillation, Evaporators, *Multistage flash distillation, *Load ball cleaning systems.

On load sponge ball cleaning systems have been proved to remove brine side fouling, maintain high heat transfer rates and high performance of MSF evaporators. Besides capital costs, service, and costs for sponge balls, the energy consumption of the system has to be taken into account. Energy consumption is influenced by hydraulic and exergetic losses of the system. Especially the exergetic losses of the system by recirculating the balls with hot or cold water influence the energy consumption considerably. With unfavourable conditions the continuous hot water recirculation from the

brine heater outlet to the coldest recovery stage increases the heat consumption by as much as 5% with a 22,000 cu m /d MSF. Specially designed ball recirculation systems bring this heat loss down to negligible values. Besides the energy consumption the operational aspects of the different ball recirculation systems have been evaluated.
W84-00224

STRUCTURE/PERFORMANCE RELATIONSHIPS OF HIGH-TEMPERATURE MSF SCALE CONTROL ADDITIVES,
Pfizer Central Research, Groton, CT.
S. W. Walinsky, B. J. Morton, and J. J. O'Neill.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 203 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Distillation, *Scaling, *Multistage flash distillation, Structure, Performance.

Low molecular weight polymers (MW sub w = 500-10,000) of maleic, fumaric, itaconic, methacrylic, acrylic, and vinylsulfonic acid were prepared and evaluated as high temperature alkaline scale inhibitors. Suppression of valcium carbonate and magnesium hydroxide scale was measured in a laboratory single-stage flash evaporator (120C) and the results compared with the performance of monomeric inhibitors such as amino and hydroxyphosphonates and phosphonocarboxylates. Some critical properties which contribute to scale control were also investigated - including the ability of these additives to inhibit crystal growth, to disperse or suspend alkaline precipitates, and to remain soluble in concentrated seawater over a range of temperatures. The relationship between the alkaline scale control performance of the various additives and their chemical structure, molecular weights and degree of ionization is discussed.
W84-00225

PRESENT TRENDS IN MATERIALS SELECTION AND PERFORMANCE IN MULTI-STAGE FLASH DESALINATION UNITS,
Little (Arthur D.), Inc., Cambridge, MA.
J. D. Birkett, and E. H. Newton.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 207-222, 8 Figs, 11 Tab, 9 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Materials testing, Multistage flash distillation.

Data is utilized from a series of worldwide surveys conducted from 1968 to 1980 for the U.S. Department of the Interior, Offices of Saline Water and Water Research and Technology as well as the recent literature to illustrate the improvements made in the materials selection process over the last several years. Trends in materials used for heat exchange tubing, flash chambers and components, pumps, water boxes, etc., are enumerated and evaluated with respect to likely service life as a function of the severity of operating conditions. Plant factor (percent of time operating at rated capacity) is correlated with design and to gain perspective is compared to plant factors achieved in the chemical processing industry generally. Present trade-off decisions with respect to materials, operating temperatures and conditions, performance factors, electrical energy consumption, and use of chemicals are summarized and commented upon.
W84-00226

EROSION-CORROSION RESISTANCE OF COPPER ALLOW C72200 IN SEA WATER CONTAINING SUSPENDED SAND,
Olin Corp., New Haven, CT. Chemicals Div.
For primary bibliographic entry see Field 8G.
W84-00227

CORROSION PROBLEMS CAUSED BY BROMINE FORMATION IN MSF DESALINATION PLANTS,
INCO Europe Ltd., Birmingham (England).
For primary bibliographic entry see Field 8G.
W84-00228

STUDIES OF THE LOCALISED-CORROSION BEHAVIOUR OF SOME STAINLESS STEELS, INCOLOY 825 AND TITANIUM IN SEAWATER,
Glasgow Univ. (Scotland). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 8G.
W84-00229

SEA WATER INTAKE AND ITS EFFECT ON HEAT REJECTION DESIGN AND MATERIAL FOR FLASH DISTILLATION PLANT,
M. H. A. El-Saie, M. S. I. Kafrawi, and A. K. T. A. Karim.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 257-267, 3 Figs, 7 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Seawater, Distillation, *Multistage flash distillation, Jetties, Settling basins, *Suspended solids, Pretreatment of water.

The suspended matter in sea water plays a big role in the design of seawater intake and heat rejection section. The seawater intake usually depends on the shore nature and water quality. Chemical treatment can handle marine growth and bacteria but the suspended matter in the seawater needs further treatment usually by settling basin and screens, these are normally costly and need a minimum plant size to be economical. For relatively small installation of up to about 15 MGPD plant, other solutions can be adopted in the seawater design and the choice of materials for the heat rejection section. For a seawater intake of up to 30,000 or 40,000 cu.m./hour for a desalination plant with a large variation of temperature between summer and winter and suspended mattter in a certain range and sizes of grain, it is more economical to have a jetty with a pressurized rotary screen and titanium tube for the heat rejection section instead of settling basin and copper nickel tubes and seawater recirculation. This will save at least 2% of the total cost of the plant. Also the execution of seawater intake with jetty is much quicker than with a settling basin.
W84-00230

ACID CLEANING AND PASSIVATION OF POWER PLANT CONDENSERS AND DESALINATION PLANTS,
Rome Univ. (Italy). Ist. di Chimica Applicata ed Industriale.
For primary bibliographic entry see Field 8G.
W84-00231

QUALITY CONTROL PROBLEMS IN COPPER ALLOY TUBES MANUFACTURING,
Rome Univ. (Italy). Ist. di Chimica Applicata ed Industriale.
For primary bibliographic entry see Field 8G.
W84-00232

PRE-SERVICE CORROSION CONTROL IN MULTIFLASH DESALINATION PLANTS,
Atel SRL, Rome (Italy).
For primary bibliographic entry see Field 8G.
W84-00233

PRESSURE DROPS ALONG THE BORES OF HOLLOW FIBRE MEMBRANES - THEIR MEASUREMENT, PREDICTION AND EFFECT ON FIBRE BUNDLE, PERFORMANCE,
Glasgow Univ. (Scotland). Dept. of Mechanical Engineering.
W. T. Hanbury, A. Yuceer, M. Tzimopoulos, and C. Byabagambi.
In: Desalination, Vol 38, Nos 1/2/3, p 301-318, 4 Figs, 2 Tab, 4 Ref. (1st. Vol of the Proc of the Intern Congress on Desalination and Water Reuse, Bahrain, Nov 29-Dec 3, 1981).

Descriptors: *Desalination, Desalination plants, Membranes, *Reverse osmosis, Hollow fibers, B9 fiber bundle performance.

Measurements of the pressure drops along the bores of hollow fibers in a B9 fiber bundle have been made under operating conditions. A theoretical model of the fiber behaviour is presented and analyzed. An analytical solution is obtained for the case of a fiber in a uniform crossflow of brine of uniform concentration and uniform pressure. A numerical procedure, making use of this analytical solution, is developed to solve the more general problem of detailed bundle behaviour. This procedure takes into account the variation of brine concentration along fiber lengths and the fact that in some cases the product concentration can be significant. Sets of experimental data, including the measurements of bore pressures, are presented and analyzed using a computer program based on the numerical procedure presented. Evidence of compression of the fiber bore diameter due to the external brine pressure is found, particularly at higher temperatures and pressures.
W84-00234

A PHYSICOCHEMICAL APPROACH FOR THE CHOICE OF POLYMERIC MEMBRANE MATERIALS FOR WATER DESALINATION BY REVERSE OSMOSIS,
National Research Council of Canada, Ottawa (Ontario). Div. of Chemistry.
T. Matsuura, Y. Taketani, and S. Sourirajan.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 319-337, 3 Fig, 7 Tab, 16 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Reverse osmosis transport, Fouling, *Polymeric membranes, Interfacial water layer.

Interfacial properties such as the thickness of interfacial water layer, the distribution coefficient of solute between interfacial and bulk water phases, and the volume of interfacial water per unit mass of polymer material have been identified as relevant physicochemical quantities governing reverse osmosis transport and determined by gas and liquid chromatography methods with respect to different polymeric membrane materials. They are further split into the contribution from the structural component of polymer repeating unit. Force constants A and D for sodium chloride, representing the repulsive force working between membrane surface and solute, have been calculated on the basis of interfacial properties obtained above. Using these forces constants, the pore sizes required to achieve 99.9% of sodium chloride separation are obtained for different polymeric membrane materials. Furthermore, the prediction procedure for the effect of preferentially adsorbed organic molecules on the separation of sodium chloride and product rate is illustrated as a model for 'fouling' in the desalination process by reverse osmosis.
W84-00235

PREDICTING FLUX DECLINE OF REVERSE OSMOSIS MEMBRANES,
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
J. C. Schippers, J. H. Hanemaayer, C. A. Smolders, and A. Kostense.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 339-348, 5 Figs, 1 Tab, 4 Ref (1st. Vol of the Proc of the Intern Congress on Desalination and Water Reuse, Bahrain, Nov 29-Dec 3, 1981).

Descriptors: *Desalination, Desalination plants, *Reserve osmosis, Mathematical model, Membrane processes, Ultrafiltration membranes.

A mathematical model predicting flux decline of reverse osmosis membranes due to colloidal fouling has been verified. This mathematical model is based on the theory of cake or gel filtration and the Modified Fouling Index (MFI). Research was conducted using artificial colloidal solutions and a pilot plant equipped with ultrafiltration membranes. Polystyrene latex spheres, having a size of about 0.05-0.08 mu m were used as a foulant. The

measured and calculated values of flux of the ultrafiltration membranes decline as a function of time and agree reasonably well. The difference between the measured and calculated values may be explained by the assumption, that initially blocking filtration occurs instead of cake or gel filtration.
W84-00236

FORMATION OF ASYMMETRIC CELLULOSE ACETATE MEMBRANES,
Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Chemical Technology.
H. Bokhorst, F. W. Altena, and C. A. Smolders.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, 8 Figs, 14 Ref, p 349-360 (1st. Vol of the Proc of the Intern Congress on Desalination and Water Reuse, Bahrain, Nov 29-Dec 3, 1981).

Descriptors: *Desalination, Desalination plants, Membranes, *Reverse osmosis, Cellulose acetate.

Cellulose acetate membranes were prepared from casting solutions containing dioxane as a solvent and varying concentrations (up to 6%) of maleic acid as an additive. Coagulation took place in water at different temperatures. The effect of these variables on membrane structure and membrane properties is related to two phenomena of phase separation in the system cellulose acetate/dioxane/water with gelation in the top layer and liquid-liquid phase separation in the sublayer of the membrane. A solution transport model is adopted which correlates membrane flux with the skin thickness and membrane salt rejection with the compactness (microstructure) in the skin. Effects of variables such as maleic acid concentration and coagulation temperature on the position of curves in the phase diagram and on membrane properties are discussed.
W84-00237

HOLLOW FINE FIBER VS. FLAT SHEET MEMBRANES - A COMPARISON OF STRUCTURES AND PERFORMANCE,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
J. K. Beasley, and R. E. Penn.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 361-372, 6 Fig, 24 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Membrane processes, *Polymers, Hollow fiber, Membranes, Flat sheet.

The reverse osmosis performance of polymeric membranes depends not only on the chemical structure of the polymer but also on the physical structure of the membrane. Percolation theory is used to describe water flux and salt passage as functions of the polymer density, or porosity, of the membrane. Water permeability increases with increasing porosity, or decreasing polymer density in the membrane. Salt passage is controlled primarily by the membrane polymer density in the surface layer on the feed side of the membrane. Experimental data on both hollow fine fiber and flat sheet membranes are consistent with the basic concepts of percolation theory.
W84-00238

PURIFICATION OF HIGH TEMPERATURE WATER BY THE REVERSE OSMOSIS PROCESS,
Tokyo Univ. (Japan). Inst. of Industrial Science.
S. Kimura, and T. Nomura.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 373-382, 11 Fig, 3 Ref. (1st. Vol of the Proc of the Intern Congress on Desalination and Water Reuse, Bahrain, Nov 29-Dec 3, 1981).

Descriptors: *Desalination, Desalination plants, *Reverse osmosis, Membranes, Water treatment, Hollow fiber, 'Hollosep', Brines.

For the high temperature desalination and purification possible use of two kinds of membranes was pursued. A dynamically formed membrane is fundamentally usable at high temperature, and a module was developed and tested. A commercially available module, hollow fiber type 'Hollosep', was found durable over 70C at 30 kg/sq cm. These modules were tested by treating the geothermal brine, that contained SiO sub 2 and NaCl. They worked well when the brine contained only ionic SiO sub 2, but was fouled by the colloidal SiO sub 2.
W84-00239

THE APPLICATION OF THIN FILM COMPOSITE MEMBRANES IN PLATE-AND-FRAME SYSTEMS FOR WATER PURIFICATION,
Danske Sukkerfabrikker, Nakskov. Driftteknisk Lab.
For primary bibliographic entry see Field 5D.
W84-00240

AN INVESTIGATION OF USING STATISTICALLY DESIGNED EXPERIMENTS AND A COMPUTER MODEL,
Florida Inst. of Tech., Melbourne. Dept. of Mechanical Engineering.
A. M. El-Nashar, and J. S. Shih.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 397 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Membranes, *Desalination, Model studies, Computer models, Membrane formation parameters.

The results are outlined of an experimental program aimed at establishing the best formation parameters for dynamic Zr(IV)-PAA membranes formed on porous ceramic supports. Parameters investigated are: pressure, circulation velocity, Zr(IV) concentration, and PAA concentration. Twenty statistically designed experiments were conducted to evaluate the effect of these four parameters on the flux and rejection of the resulting membrane at the end of the formation procedure. The results were used in a multiple linear regression computer program BMD-PIR, which develops the measured values with an accuracy of plus or minus 2%. Using these models, it is possible to form a membrane with a given value of flux or rejection within their ranges. For the range of variables used in this study, the maximum membrane rejection was 91%, corresponding to a flux of 10 gpd/ sq ft (1.7 cm/hr) for 0.05 M NaCl and 800 psi (5.4 MPa). High rejection was obtained by increasing the membrane formation pressure and by increasing the PAA concentration. High flux can be achieved by increasing the formation pressure, by increasing the Zr(IV) concentration - up to 9.0 x 10 super -4M super -, and by increasing the circulation velocity.
W84-00241

THE PERFORMANCE OF THE 12,000 M SUPER 3/DAY SEAWATER RO PLANT AT JEDDAH, SAUDI ARABIA,
Florida Inst. of Tech., Melbourne. Dept. of Mechanical Engineering.
A. M. El-Nashar, and I. Kutbi.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 399 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: Desalination, Desalination plants, Seawater plant, Reverse osmosis, Jeddah, *Saudi Arabia, Special wound elements.

The performance is outlined of the 12,000 cubic m/day seawater RO plant at Jeddah, Saudi Arabia, which started operation in February 1979. The feedwater has a 42,000-ppm TDS and a maximum seawater temperature of 32C. A first stage includes nine units, eight operating and one stand-by, and a second stage contains three units. The nine first stage and the three second stage RO units are each composed of 56 Fiberglass pressure tubes (Model 66 FRP-6) 150-mm diameter by 6.5 m long, each containing six spiral wound elements manufactured by UOP Fluid Systems Division. The plant uses Fluid System's polyamide thin film composite membrane element, Model 1501 TFC. The pretreatment is composed of dual media filtration, acid injection, sodium hexametaphosphate injection and cartridge filtration.
W84-00242

PRETREATMENT AND OPERATING EXPERIENCE ON REVERSE OSMOSIS PLANT IN THE MIDDLE EAST,
Paterson Candy International Ltd., Laverstoke (England).
D. Pepper.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 403-417, 2 Figs, 5 Tab, 1 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Reverse osmosis, Pretreatment, Brackish water, Middle East.

The pretreatment methods which can be used to make a water suitable for satisfactory processing in a reverse osmosis plant are discussed. This discussion is followed by case histories of plants operating on various waters in the Middle East from normal brackish waters to very strong brackish water (12,000 mg/l T.D.S.) containing H sub 2 S, and mobile plants for treating brackish and sea waters.
W84-00243

CONTROLLING BIOLOGICAL ACTIVITY IN A SURFACE WATER REVERSE OSMOSIS PLANT,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Haskell Lab. for Toxicology and Industrial Medicine.
G. E. Bettinger.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, 3 Figs., 4 Ref. p 419-424 (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, *Desalination plants, *Reverse osmosis, Biological fouling, Permasep B-9 super (R).

A plant, built in 1972, has a total of 24 permeators operating in 4 blocks which are reject staged 4:2. The feed water TDS is 475 milligrams per liter and the silt density index (SDI) after pretreatment is less than 3. Feed pressure is 400 psig and product pressure 10 psig, with an interstate pressure drop of 35 psig. The plant operates at a feed temperature of 20C and an overall conversion of 70%. The product is used for boiler feed and chemical process water. Since its inception this plant has exhibited a problem in maintaining the design product flows and the operating conditions evolved such that two banks of permeators operated for one week, and then a citric acid, formaldehyde cleaning procedure was used on the two banks the second week. The other two banks of Permasep super (R) units, which had been cleaned and sterilized the week before, were then used. The plant was able to operate under these conditions but the cost of manpower and cleaning chemicals required to maintain satisfactory product water flow and quality was excessive.
W84-00244

PRETREATMENT OF SEAWATER RO FEED BY MEANS OF COAGULATION-FILTRATION,
Kobe Steel Ltd. (Japan). Water and Wastewater Engineering Dept.
H. Tsuge, S. Suda, and T. Matsumura.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 425-436, 8 Fig, 2 Tab, 6 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination processes, Seawater, Pretreatment, *Reverse osmosis, *Coagulation, Hydrogen ion concentration, Coagulation-filtration.

The effect of pH of the filtrate on the head loss in the inline coagulation-filtration for the pretreatment of reverse osmosis seawater desalination was

investigated. The experiment was carried out using a double media filter with aluminum sulfate as a coagulant. The filtration characteristics were dependent on the pH of the filtrate. The rate of elevation in the head loss and the amount of suspended particles in the filtrate decreased with an increase in the pH, over the range of experimental conditions. The results were briefly considered in relation to the deposit morphology of suspended particles on the surface of the filter grain.
W84-00245

CHEMICAL TREATMENT FOR REUSE OF WASTEWATER EFFLUENTS IN SAUDI ARABIA,
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
For primary bibliographic entry see Field 5D.
W84-00246

SINGLE-PASS DESALINATION OF HIGH SALINITY SEAWATER WITH REVERSE OSMOSIS,
Toyabo Co. Ltd., Otsu (Japan). Katata Research Center.
H. Matsui, H. Matsumoto, H. Kuzumoto, M. Sekino, and Y. Nimura.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 441-447, 2 Fig, 4 Tab, 2 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: Desalination, Desalination plants, Reverse osmosis, Membrane processes, 'Hollosep', Salinity, Seawater.

Two types of new 'HOLLOSEP' have been developed for single-pass desalination of high salinity seawater. One is a high pressure and high temperature module, type 'HPT'. The performance of this new type HOLLOSEP is analyzed in the case of desalination of high salinity seawater under a high pressure of 75kg/sq cm G at high temperature of 40C. The operation costs can be reduced by this high pressure and high temperature operation system. The other is a large size module containing five elements of 12 inches diameter, type 'JM-12'. This module has been developed to reduce the water cost by enlarging the diameter and the length of a vessel coupled with the improvement in water flux rate of the hollow fiber membranes. The fresh water productivity of this module is 150 cu m/day under the conditions of 3.5% NaCl feed water, 30% product water recovery at 55kg/sq cm G.
W84-00247

DEVELOPMENT OF THE PEC-1000 COMPOSITE MEMBRANE FOR SINGLE-STAGE SEAWATER DESALINATION AND THE CONCENTRATION OF DILUTE AQUEOUS SOLUTIONS CONTAINING VALUABLE MATERIALS,
Toray Industries, Inc., Otsu (Japan).
M. Kurihara, N. Harumiya, N. Kanamaru, T. Tonomura, and M. Nakasatomi.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 449-460, 11 Figs, 2 Tab (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination plants, Anion exchange, *Membranes, *Reverse osmosis, Single stage seawater desalination, Piezodialysis, Mosaic membranes, Potable water.

The PEC-1000 membrane element has a capability to produce the potablewater economically by a single-stage seawater desalination and the possibility in the application to the concentration and recovery of valuable materials. The basic performance is described of the PEC-1000 element and the durability test results on the single-stage seawater desalination, both in the low and high salinity seawater feed with high feedwater temperatures. The membrane performance is described by concentrating water soluble valuable organic materials of low molecular weight and valuable inorganic compounds.
W84-00248

PIEZODIALYTIC TRANSPORT ACROSS CHARGE-MOSAIC MEMBRANES,
Wroclaw Technical Univ. (Poland). Inst. of Environmental Engineering.
G. Blazejewska-Wisniewska, and T. Winnicki.
In: Desalination, Vol 38, Nos 1/2/3, p 461-471, 9 Fig, 7 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination plants, Anion-exchange, *Membrane processes, Piezodialysis, Mosaic membranes.

The highest concentrations are obtained for symmetric electrolytes and membranes of the second series. When the capacity of the anion-exchange resins in those membranes increases, so does the concentration of the solutions. In second-series membranes the influence of ionic polarization was the least as compared to the remaining two series. All of the membranes under study permit concentration of asymmetric electrolytes only at an initial concentration of 0.05 kmol/cu m. Retention of bivalent ions by charge-mosaic membranes seems to be promising in that it suggests the possibility of separating bivalent from monovalent ions. The optimum parameters at which the concentration effects were the highest, are the following: pressure, 11.3 MPa; initial concentration of the electrolyte, 0.05 kmol/cu m.
W84-00249

THE FT-30 SEAWATER REVERSE OSMOSIS MEMBRANE-ELEMENT TEST RESULTS,
FilmTec Corp., Minneapolis, MN.
R. E. Larson, J. E. Cadotte, and R. J. Petersen.
In: Desalination, Vol 38, Nos 1/2/3, p 473-483, 6 Figs, 1 Tab, 4 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Desalination apparatus, *Reverse osmosis, *Membranes, Thin-film composite, FT-30.

A thin-film composite reverse osmosis (RO) membrane has been developed that provides excellent performance when used in single-pass seawater systems. This membrane, designated FT-30, gives superior performance in such areas as flux, salt rejection, chemical stability, and microbiological resistance. In addition, it is resistant to some oxidizing disinfectant agents, although it is not fully resistant to chlorine; elements fabricated from the membrane have shown damage after 2,000 to 2,500 hours exposure to seawater at 0.5 milligrams per liter (mg/l) active chlorine. The membranes can operate continuously at active chlorine concentrations below 0.2 mg/l. Several long-term studies were carried out at the OWRT Wrightsville Beach Test Facilities. In actual trials in seawater systems, salt rejections as high as 99.5% and fluxes of 23 gfd have been obtained when tested at 800 psi and 25C. Some of the elements have been in continuous operation for over 4,000 hours with no deterioration in salt rejection and with only the normal flux decline usually associated with compaction and scaling. Other elements have been installed in small seawater systems with normal intermittent use for almost two years with no serious loss in performance.
W84-00250

BUILDING AND COMMISSIONING THE 3.0 MGD SEAWATER RO PLANT FOR KEY WEST, FLORIDA,
Water Services of America, Inc., Milwaukee, WI.
W. W. Boesch.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 485-496, 11 Figs. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Reverse osmosis, Membrane processes, Key West, Florida, Seawater.

The fast deliveries and the reliability of a seawater reverse osmosis plant has been demonstrated. The performance of a large plant using the hollow fiber polyamide membranes shows that good potable water can be obtained through a single pass design rather than the more costly two pass design. The comparison between thermal plants and seawater RO points up large contrasts in simplicity of design, compactness, delivery time, reliability and cost.
W84-00251

UTILIZATION OF THE WASTE CONCENTRATED SEAWATER IN THE DESALINATION PLANTS,
Asahi Glass Co. Ltd., Chiba (Japan).
For primary bibliographic entry see Field 5D.
W84-00252

WATER SOFTENING BY DIFFUSION USING CATION EXCHANGE MEMBRANES,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
For primary bibliographic entry see Field 5D.
W84-00253

DEMINERALIZATION BY ELECTRODIALYSIS USING AMPHOLYTIC ION-CONDUCTING SPACERS,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
For primary bibliographic entry see Field 5D.
W84-00254

DESALTING 36,000 PPM WELL WATER WITH ELECTRODIALYSIS - A 5-YEAR REPORT,
Ionics, Inc., Watertown, MA.
H. C. Valcour, Jr., and K. D. McElhinney.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 529-536, 2 Figs, 2 Tab, 1 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Manama, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Electrodialysis, Anion membranes, Well water.

The 36,000-ppm TDS well water is saturated with calcium sulfate and contains high levels of hydrogen sulfide (reported as high as 190 ppm). The 42,000-USGPD plant has now been in service for nearly 5 years and has never failed to provide the potable water needs of the desert camp that it serves. The operation of the pretreatment section of the plant has been modified to reduce the amount of lime fed to the solids contact clarifier, thereby reducing the quantity of acid required for pH reduction of the feed water. The only major modification to the ED portion of the plant has been the installation of new type anion membranes. The membrane stacks are now primarily equipped with two types of anion membranes, both of which operate at a lower electrical resistance and higher ion transfer efficiency. The result of these more efficient anion membranes is a lower power consumption and higher production rate. Improvements to the electrode system have resulted in continuous membrane stack operating periods of over 6000 hours between disassemblies.
W84-00255

TREATING BAHRAIN ZONE C GROUNDWATER USING THE EDR PROCESS,
Ionics, Inc., Watertown, MA.
D. F. Brown.
In: Desalination, Vol 38, Nos 1/2/3, p 537-547, November 1981, (1st. Vol of the Proceedings of the International Congress on Desalination and Water Reuse, Manama, Bahrain, November 29-December 3, 1981). 3 Tab, 3 Fig, 3 Ref.

Descriptors: *Desalination, Desalination plants, *Electrodialysis, Desalination apparatus, Membrane processes, Bahrain, Electrodialysis reversal.

Developing and applying efficient water desalination technologies for treatment of Zone C groundwater appears to be an essential factor in maintaining an adequate water supply for the Island of Bahrain. The quality of this source (11,000 ppm TDS) will increase capital and operating costs of

desalting systems as compared to units currently operating on the Zone B brackish water sources. Conceptual design studies have shown that EDR is directly applicable to Zone C desalination requirements. Pertinent operating characteristics are reviewed of the Mediterranean installation and estimated operating parameters and costs for Bahrain Zone C water treatment are projected. Factors contributing to the improvement in EDR system operating efficiency which make treatment of the Zone C type water feasible are: new aliphatic membranes which improve electrical efficiency, a special electrode Clean-In-Place system which reduces acid consumption for periodic stack cleaning, and a new time phased rversal system which increases efficiency of polarity reversal in multistage units needed to desalt 10-12,000 ppm TDS feed waters. The EDR process offers an attractive, economical alternative for the Zone C desalination requirements.
W84-00256

PARAMETRIC TESTS OF AN ELECTRODIALYSIS REVERSAL (EDR) SYSTEM WITH ALIPHATIC ANION MEMBRANES,
Ionics, Inc., Watertown, MA.
D. Elyanow, R. G. Parent, and J. R. Mahoney.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 549-565, 3 Figs, 4 Tab (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Manama, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Electrodialysis, Desalination apparatus, EDR, Roswell Test Facility, Aliphatic anion membranes, Aquamite X EDR.

During 1980, parametric studies were performed to compare the performance of aliphatic anion membranes to standard anion membranes in an electrodialysis reversal (EDR) system. An Ionics AQUAMITE X EDR unit was used to desalt a high sodium chloride, 4100 mg/l TDS feed water. During these tests, the product salinity averaged 388 mg/l at an average production rate of 25,800 USGPD. The use of aliphatic membranes reduced the desalting energy consumption from 8.1 kwh/kGal with standard membranes to 6.8 kwh/kGal with aliphatic membranes at 75% recovery and, at 92% recovery, from 14.6 kwh/kGal for standard membranes to 11.0 kwh/kGal for the aliphatics. Slightly higher water recoveries were also possible with the aliphatic membranes as they exhibited less water transfer. A maximum recovery of 94% was obtained without operational problem despite calcium sulfate (gypsum) supersaturation levels of up to 165% in the waste stream. The following characteristics are desirable for an EDR plant to treat a high sodium chloride 4100-ppm water: (1) Aliphatic anion membranes for reduced energy consumption, (2) Separate feed for brine and electrode flows for nearly complete recovery of a limited higher quality brackish water source, and (3) 30-minute reversal cycle to improve production and increase recovery.
W84-00257

DESALINATION OF SEA WATER BY AN ELECTRODIALYSIS-REVERSE OSMOSIS HYBRID SYSTEM,
Forschungsinstitut Berghof G.m.b.H., Tuebingen (Germany, F.R.).
H. Schmoldt, H. Strathmann, and J. Kaschemekat.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 567-582, 11 Figs, 3 Ref. 1st. Vol of the Proc. of the

Descriptors: *Desalination, Desalination plants, Desalination apparatus, *Reverse osmosis, Electrodialysis.

In the RO desalination of sea water with salt contents in excess of 4.0% TDS, a two-stage procedure is necessary today to guarantee reliable, longterm operation and satisfactory product water quality. In general, in a two-stage plant, the salt concentration of the sea water is reduced to about 2000 to 4000 ppm in the first stage and to less than 500 ppm in the second stage. The advantages of the two-stage over a one-stage system are high reliability and possibly lower costs.
W84-00258

ENERGY-SAVING ELECTRODIALYZER FOR SEA WATER DESALINATION,
Tokuyama Soda Co. Ltd. (Japan).
T. Mizoue, Y. Takasaki, Y. Tani, S. Urabe, and E. Asada.
Desalination, Vol 38, Nos 1/2/3, November 1981, p 583 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Manama, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Desalination apparatus, *Electrodialysis, Seawater, Skid-mounted electrodialyzer.

An energy-saving skid mounted electrodialyzer was developed for sea water desalination. This equipment is suitable for making fresh water for drinking and industrial use. To desalinate 25C sea water and turn out one ton of product water. This equipment consumes only 8.5 KWH of electricity and 0.09 Kg of concentrated sulphuric acid. Low energy consumption is achieved by adoption of low electric resistance membranes, new spaces and new designed one pass type system. Low running cost, easy maintenance and low initial installment cost place the equipment good position in the desalination field. And also we applied high temperature electrodialysis up to 50C of sea water and get figure 6.0 KWH for one ton of product water.
W84-00259

WATER REQUIREMENTS OF AN INLAND NUCLEAR POWER STATION, ENGINEERING AND ECONOMIC ASPECTS,
Israel Electric Corp. Ltd., Haifa.
A. Beck, and M. Schaal.
Desalination, Vol 40, Nos 1/2, January 1982, p 19-24, 2 Tab, 4 Ref.

Descriptors: Water requirements, *Desalination, *Nuclear Powerplants, Engineering, Economic aspects, *Israel, Cooling towers.

Water requirements for construction and operation of a 950 MWe nuclear power plant are estimated. For the bulk of water needed, i.e. condensor cooling, quantities assessed are 12.5 million cu m/year for sea water and 35 million cu m/year for fresh water. Breakeven water costs are calculated below which use of wet cooling towers is more economical than dry cooling towers. Desalinated water costs (70 cents/cu m) are lower than breakeven costs ($1.42/cu m) i.e. it is likely to be more economical to desalt water using some form of wet, rather than dry, cooling towers. It is even more economical to use sea water makeup without desalination but with proper design and choice of materials for cooling towers.
W84-00260

WATER RESOURCES IN ISRAEL AND THE NEED FOR DESALINATION,
Ministry of Agriculture, Tel-Aviv (Israel). Water Commission.
M. Ben Meir.
Desalination, Vol 40, Nos 1/2, January 1982, p 15-18.

Descriptors: *Desalination, Seawater, *Water resources development, Water policy, Planning, *Israel.

Considering the various factors involved in determining timing for introduction of seawater desalination in Israel and the desirable scope, it is presently assessed that a 50-100 MCM/yr desalination plant should operate by the end of the century. The appropriate timing for the introduction of seawater desalination in Israel, and the scope of such operations, can be determined only after due consideration of the following topics: (1) climatic conditions, (2) hydrological situation, (3) possibilities for water resource development, (4) macroeconomic implications of water shortage, (5) the planned geographic and demographic distribution of the population, (6) physical planning in the light of national and social goals, (7) the need to ensure food supplies, and (8) water in relation to the geopolitical situation.
W84-00261

WATER FROM FOSSIL AQUIFERS AS A POTENTIAL SUPPLY SOURCE FOR SOLAR DESALINATION PLANTS ON A REGIONAL SCALE,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
A. Issar, and G. Oron.
Desalination, Vol 40, Nos 1/2, January 1982, p 25-32, 1 Fig, 8 Ref.

Descriptors: *Water supply, *Desalination, Desalination plants, *Solar desalination, *Israel, Hydrogeology, Hydrogeochemistry.

Studies of the hydrogeology and hydrogeochemistry of the water in the Judea Kurnuk and Arad Group aquifers in the Negev (Cenomanian, Lower Cretaceous and Jurassic) reveal that under a large area of the Negev an aquiferous section 1000- to 1500-m thick is saturated with brackish water. Data derived from oil and water wells enabled the mapping of the various water groups which in turn made it possible to map the chemical composition of the water in the different regions. The potential quantities of water, from the point of view of storage, are in the order of hundreds of billions of cubic meters. Annual pumping amounts, however, are a function of management policy. The annual pumping potential for the next 30 years from the Kurnub Group (Lower Cretaceous) is about 60-100 million cu m, with an allowance of 20-100 m for the reduction of head. The cost of desalination may be reduced if one takes water whose salinity is a little above the threshold of direct application for agricultural use and mixes it with the distilled water supplied by the solar distiller. The chances of achieving even lower costs for distilled water are promising as the water pumped has an average temperature of 40C. Thus, the efficiency of the solar stills may be greater, and may even enable night distillation to take place. The application of solar distillation thus appears promising in the Arava, where the special climatic conditions give a marginal benefit value of $1.00 p/cu m of water for winter vegetables.
W84-00262

PRESENT AND FUTURE ENERGY ASPECTS IN VC, MED SINGLE AND DUAL PURPOSE DESALINATION PLANTS,
Israel Desalination Engineering Ltd., Tel-Aviv.
J. Weinberg, and U. Fisher.
Desalination, Vol 40, Nos 1/2, January 1982, p 49-61, 2 Fig, 8 Tab, 3 Ref.

Descriptors: *Desalination, Desalination plants, Distillation, *Vapor compression, *Multieffect distillation, Heat transfer.

The specific energy consumption as well as investment for present vapour compression (VC) and multieffect distillation (MED) processes are demonstrated. Power consumption for coal dual-purpose stations is 6.5-7.4 kWh/cu m, while for nuclear stations it goes down to 5.1-6.1 kWh/cu m. Improvements in heat transfer and other future modifications may lead to even lower values, i.e., 5.5-6.4 kWh/cu m and 4.4-5.4 kWh/cu m in case of nuclear dual-purpose stations. The cases of VC and single-purpose MED plants are discussed as well. Efficient VC units which use waste energy produce water with energy demand of 8 kWh/cu m. The role that capital costs play in the evaluation of plant expenses is discussed too. In plants where aluminium heat transfer tubes are installed, the fraction of energy used for aluminium production out of the total investment will remain stable, because of improvements in aluminium manufacturing processes. Enhanced heat transfer surfaces with inexpensive additional modifications should be developed. It is worthwhile to check the extension of a VC process which is prefered over MED single-purpose plants for up to 2-mgd enterprises.
W84-00263

AVAILABLE ELECTRICITY LOSS FOR LOW GRADE HEAT,
Israel Electric Corp. Ltd., Haifa.
M. Schaal.
Desalination, Vol 40, Nos 1/2, January 1982, p 77-85, 4 Fig, 5 Ref.

Descriptors: *Desalination, Electric powerplants, Dualpurpose plants, Turbines, Specific energy demand.

A method was developed calculating loss of available electricity production caused by elevated back pressures used in dual purpose powerplants. The method is based on practical data provided by turbine manufacturers. The method is applied to calculate specific energy demands for desalinated water. It is assumed that the steam is supplied from turbine exhaust to desalination plant at a moderate pressure of 12 in of Hg sub (abs).
W84-00264

COST OF MARGINAL ENERGY CHARGEABLE TO DESALINATION IN THE ISRAEL ELECTRIC CORP. GENERATING SYSTEM,
Israel Electric Corp. Ltd., Haifa.
M. Schaal, A. Schwartzman, and A. Angel.
Desalination, Vol 40, Nos 1/2, January 1982, p 87-94, 1 Fig, 6 Tab, 1 Ref.

Descriptors: *Desalination, Marginal costs, *Electric power costs, Electric powerplants, Costs, *Israel, Ashdod, Tel Aviv, Haifa.

The marginal kWh cost was calculated by the addition of 20 MW to the base load curve and by the division of the additional fuel consumption by the additional demand. The result was highly sensitive to the growth rate and expansion program. The marginal cost ranges between 47.4 to 60.5 mills/kWh as compared to average IEC energy cost ranging between 22.5 to 31.5 mills/kWh. The marginal cost is that which corresponds to the base load. To get the specific energy cost for the desalted water, the marginal kWh cost should be multiplied by the specific energy demand.
W84-00265

TRENDS IN THE APPLICATION OF SOLAR ENERGY TO WATER DESALINATION,
R. A. Brosh.
Desalination, Vol 40, Nos 1/2, January 1982, p 95-102.

Descriptors: *Desalination, *Solar energy, Distillation, Electric power costs.

Solar desalination is more expensive than fossil energy because of high capital costs for collecting systems. The types of solar energy processes are: (a) Applied to direct distillation of water, energy is collected and used in the same vessel, (b) Solar energy is collected in one unit and desalination performed in separate unit. Some calculations are made indicating development work required for successful application of solar energy.
W84-00266

SOLAR ENERGY AS A SOURCE FOR PRODUCTION OF POWER AND DESALINATED WATER,
Israel Desalination Engineering Ltd., Tel-Aviv.
A. Ophir, and N. Nadav.
Desalination, Vol 30, Nos 1/2, January 1982, p 103-124, 3 Fig, 8 Tab, 2 App, 13 Ref.

Descriptors: *Desalination, *Ponds, *Solar energy, Dual purpose plants, Dead Sea, Mediterranean.

A detailed calculation utilizing solar ponds for generation of electricity and seawater desalination are presented. Three cases are studied: single purpose electricity generation plants at the Dead Sea and Mediterranean regions and a dual purpose plant for electricity generation and seawater desalination. The results indicate that where a price of 0.6-0.7 $/ton can be economically justified, the dual purpose plant becomes the most attractive of the alternatives compared for electrical power generation as well.
W84-00267

DESALINATION PLANT USING LOW GRADE GEOTHERMAL HEAT,
Israel Desalination Engineering Ltd., Tel-Aviv.
A. Ophir.
Desalination, Vol 30, Nos 1/2, January 1982, p 125-132, 1 Fig, 1 Tab, 1 Append.

Descriptors: *Desalination, Desalination plants, Distillation, Brines, *Geothermal studies, *Israel.

Based on the possibility that a geothermal hot brine source may be found in Israel, a preliminary economic study using such a source for desalination is presented. The two cases evaluated are for a 110C and 130C brinesources. The cost of desalinated water from a geothermal brine source is 0.5 $/ton. Such a low price for seawater desalination can now be achieved only with large multi-effect distillation plants coupled with big power stations using low back pressure steam.
W84-00268

GEOTHERMAL RESOURCES IN ISRAEL,
Israel Inst. of Petroleum Engineering, Tel-Aviv.
L. Koifman.
Desalination, Vol 40, Nos 1/2, January 1982, p 133-134.

Descriptors: *Geothermal resources, Geophysics, Thermal springs, *Israel.

There are no significant geothermal anomalies in Israel. A survey of the temperatures registered on electric logs run in the oil exploration wells shows that the geothermal gradients encountered are normal, ranging from 1.7 to 2.2C/100 m in shaly formation and from about 3.0 to 4.0C/100 m in massive carbonated layers. Only in Dvora (Mount Tabor) at depths below 4000 m do we reach gradients of larger magnitudes. It was established beyond any reasonable doubt that the top Jurassic in the coastal plain, at depths of about 2700 m is at a temperature of 110C or more.
W84-00269

DESALINATION AT INLAND SITES,
Israel Desalination Engineering Ltd., Tel-Aviv.
A. Gendel.
Desalination, Vol 30, Nos 1/2, January 1982, p 135-142, 3 Fig, 3 Ref.

Descriptors: *Desalination, Desalination plants, *Dual-purpose plants, Costs, *Mediterranean-Dead Sea canal.

Locating a dual purpose desalination plant along the Mediterranean-Dead Sea Canal is feasible and should be seriously considered. The cost of water produced in the inland site will be higher by a few percentage points than in the sea side case. This cost would be considerably reduced if the product water would be mixed with locally available brackish water.
W84-00270

PRELIMINARY CONSIDERATIONS OF COMBINING A LARGE REVERSE OSMOSIS PLANT WITH THE MEDITERRANEAN-DEAD SEA PROJECT,
Mekoroth Water Co., Tel Aviv (Israel).
P. Glueckstern.
Desalination, Vol 40, Nos 1/2, January 1982, p 143-156, 3 Fig, 2 Tab, 7 Ref.

Descriptors: *Desalination, Desalination plants, *Reverse osmosis, Gravity flow, *Mediterranean-Dead Sea Canal.

The potential benefits were investigated of a reverse osmosis plant designed in conjunction with the Mediterranean-Dead Sea project in order to utilize gravity pressure as partial energy source for the desalting process. Energy requirements of alternative conceptual operating schemes were evaluated and compared to those of conventional reverse osmosis. Overall comparative economics of conventional and conjunctive systems were analyzed and discussed.
W84-00271

OPERATION OF A HORIZONTAL TUBE BRINE CONCENTRATOR,
Israel Desalination Engineering Ltd., Tel-Aviv.
J. Weinberg, and Y. Rotstein.
Desalination, Vol 40, Nos 1/2, January 1982, p 159-168, 2 Tab, 2 Fig, 18 Refs.

Descriptors: *Desalination, Desalination apparatus, *Scaling, Wastewater treatment, Evaporators, Concentrator.

An apparatus to concentrate solutions was developed using know how on seawater evaporators and treatment of sea and product water. A pilot plant at the Research Center in Tel-Baruch, near Tel Aviv has been operated since the middle of 1977. The plant is a single effect concentrator coupled to a condenser, with a capacity of up to 400 kg vapour per hour. The prevention of scale (Calcium sulphate, Calcium carbonate or other constituents) has been carried out by combined techniques of seeding process plus a threshold treatment.
W84-00272

ELECTRODIALYSIS UNIT: OPTIMIZATION AND CALCULATION OF ENERGY REQUIREMENT,
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Div. of Membranes and Ion-Exchangers.
E. Korngold.
Desalination, Vol 40, Nos 1/2, January 1982, p 171-179, 2 Fig, 3 Tab.

Descriptors: *Desalination, Desalination plants, *Electrodialysis, Electric power demand.

An industrial unit which optimizes the parameters of the electrodialysis process has been developed. The total energy requirement with this unit is about 1.2 kWh/cu m for brackish water of 2400 ppm and 3.3 kWh/cu m for water of 5000 ppm. For sea water desalination the system may be optimized by operating it with thin cells (0.4 mm) and thin polyethylene membranes (0.1 mm). In such a system the energy requirement for the desalination of sea water will be 12 k/Wh/cu m for operation at 20C and 6.7 kWh/cu m at 70C.
W84-00273

EFFECT OF THE ENERGY CRISIS ON WATER DESALINATION AND WASTE WATER RECYCLING BY ION EXCHANGE,
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Div. of Membranes and Ion-Exchangers.
Y. Egozy, and E. Korngold.
Desalination, Vol 40, Nos 1/2, January 1982, p 181-189, 3 Fig, 3 Tab, 8 Ref.

Descriptors: *Desalination, *Ion exchange, Water reuse, Wastewater renovation.

The cost, and its breakdown into components, of an ion exchange process for desalination and waste water recycling is presented. Using the effect of the 1973-4 jump in the price of energy on the cost of treatment, the expected future trend is calculated. The net energy component in ion exchange water treatment is 14.5% when lime is used for regeneration, and 17% when NaOH is used. The substitution of lime for NaOH reduces the treatment cost and makes the ion exchange process an economical method for desalination and waste water recycling. 'Non-conventional' approaches such as a continuous fixed-bed process, a system including recycling of regenerants, regeneration thermally or with waste acids are also discussed.
W84-00274

PRODUCTION OF ELECTRICAL POWER FROM CONCENTRATED BRINES,
Israel Desalination Engineering Ltd., Tel-Aviv.
N. Nadav, and A. Ophir.
Desalination, Vol 40, Nos 1/2, January 1982, p 197-211, 1 Fig, 2 Tab, 6 Ref.

Descriptors: Electric power, Brines, Brackish water, Falling film horizontal tube absorption condenser, Flash chamber, Condensers, Flash evaporation, Dead Sea, Israel.

The price of electrical power, produced by burning fossil energy sources has reached a level where other alternatives become competetive. One of these alternatives is dilution of concentrated brines. It is possible to regard these very concentrated brines (as well as fossil fuels) as an accumulated solar energy radiated over millions of years, causing brines to attain a very high salt concentration. Dilution of these brines results in releasing heat of dilution and the very low vapor pressure of these brines can be utilized as a driving force for vapor condensation. A source of highly concentrated brine is available at the Dead Sea Works where 88 million tons of such brine is today returned to the Dead Sea as waste streams. Dilution of this brine at a ratio of three (brine) to one (vapor) by weight can supply 40 MW of electrical power. The proposed process is based on the use of two well-proven process elements, a falling film horizontal tube absorption condenser and a flash chamber.
W84-00275

THE JOINT U.S.-ISRAEL DESALINATION PROJECT STATUS REPORT AND THE IMPACT OF RISING ENERGY COSTS ON THE PROGRAM,
Israel-U.S. Desalination Project Authority, Tel-Aviv.
A. Peled, and J. Finke.
Desalination, Vol 40, Nos 1/2, January 1982, p 217-223, 9 Figs.

Descriptors: *Desalination, Desalination plants, *Multieffect distillation, Seawater, *Distillation.

The Joint U.S.-Israel Desalination Project is discussed which was initiated in 1975 with the main objective of developing, designing, constructing and demonstrating the operation of a large -5/10 MGD - MED seawater desalination plant, using exhaust heat from an existing 50-MW steam power plant.
W84-00276

THE IMPACT OF DESALINATED WATER QUALITY ON ENERGY COSTS,
Italconsult, Rome (Italy).
E. Gabrielli.
Desalination, Vol 40, No 3, p 391-394, March 1982. (Comprising the Round Table Conference on Influence on Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980). 4 Ref.

Descriptors: *Desalination, Seawater, *Energy, *Costs.

Lack of clarity in defining the scope of work of a desalination process may often lead to questionable or meaningless results when economic analysis is performed. In particular the incidence of the energy cost cannot be compared when different plants treat the same raw material, in this case seawater, but yield different products; that is to say waters which have residual TDS differing by orders of magnitude and which are not therefore necessarily equivalent for the application in question. Criteria are suggested for ensuring clearer definition of the problem in order to help evolve a methodology which allows processes to be compared on a perfectly sound economic basis.
W84-00277

DEVELOPMENT OF DISTILLATION PROCESSES RESPONSIVE TO ENERGY COST ESCALATIONS,
California Univ., Berkeley. Sea Water Conversion Lab.
H. H. Sephton.
Desalination, Vol 40, Nos 3, p 375-384, March 1982. (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), 5 Fig, 20 Ref.

Descriptors: *Desalination, Desalination plants, *Desalination apparatus, *Distillation, Energy, Costs.

Recent developments in distillation processes that respond to the continuing escalation in energy cost are reviewed. The most effective developements are considered to be those providing increased performance ratios and heat transfer rates, the utilization of waste heat or low grade heat including insolation, and improvements in the reliability of equipment and processes within reasonable capital cost levels. Suggestions are offered as themes for future research and development in each of these area.
W84-00278

ENERGETIC ASPECTS OF THE FOULING OF MSF DESALINATION PLANTS WITH AND WITHOUT THE USE OF ON LOAD BALL CLEANING SYSTEM,
K. Eimer.
Desalination, Vol 40, No 3, p 363-372, March 1982. (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), 1 Tab, 8 Fig, 18 Ref.

Descriptors: *Desalination, Desalination plants, *Multistage flash, Energy, Fouling, Load ball cleaning system, Scaling.

Multi stage flash (MSF) desalination plants are designed with specific permissible fouling factors. When these conditions are met, the performance is said to 'meet design'. With single-purpose desalinators, fouling of the brine heater can be compensated for by increasing the steam pressure without substantial increase of heat consumption and within the limits of the boiler pressure. With dual-purpose desalinators, the brine heater pressure will influence the efficiency of the turbine process. Fouling of the heat recovery section increases the heat consumption of the MSF process. The distillate production can be maintained within the limits of the boiler. Typical 'design fouling factors' have been compiled from literature. The influence of fouling factor on specific heat consumption has been calculated for typical MSF design conceptions, as well as the increase of water costs per cu m with different fuel prices. The costs of various scale prevention methods have been evaluated. The effectiveness of such countermeasures can be quantified by plant experience. This analysis of cost/return gives a basis for a correct economic comparison.
W84-00279

SEAWATER REVERSE OSMOSIS WITH ENERGY RECOVERY,
Esmil International B.V., Amsterdam (Netherlands).
W. A. G. Hoeting.
Desalination, Vol 40, No 3, p 357-361, March 1982. (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), 2 Tab, 1 Fig.

Descriptors: Desalination, Desalination plants, Reverse osmosis, Seawater, Energy recovery, Porto Sauto, Madeira Islands.

The Porto Santo seawater reverse osmosis plant has been designed to provide per day 500 cu m of potable water with a total dissolved solids content of 500 ppm from seawater with a total dissolved solids content of about 34000 ppm. The plant consists of four independent units with an output of 125 cu m per day each. Three units are fed by high pressure pumps equipped with electro-motors and one unit by a high pressure pump equipped with a hydro-turbine. The high pressure reject stream from each unit is directed into a manifold pipe which powers the hydroturbine. In this way power consumption of the high pressure pump is reduced by 25%. Without energy recovery consumption would have been 7.5 kWh/cu m and with the installed turbine this is as low as 5.6 kWh/cu m of product.
W84-00280

HIGH TEMPERATURE DISTILLATION PROCESS WITH SEA WATER FEED DECALCIFICATION PRETREATMENT,
Aquila Univ. (Italy). Ist. di Chimica Applicata ed Industriale.
D. Barba, G. di Giacomo, F. Evangelista, and G. Tagliaferri.
In: Desalination, Vol 40, No 3, p 347-355, March 1982. (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Producion during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), 1 Tab, 6 Fig, 13 Ref.

Descriptors: *Desalination, Desalination plants, Distillation, Ion exchange, Seawater, *Pretreatment of water, *Cation exchange.

The performance ratio of a desalination plant can be increased to reach 16-18 by coupling it with a decalcification pretreatment by ion exchange of the sea-water make-up, thus making MSF comparable with RO from an energy point of view. A new strong cationic resin DECAL has been tailored; its main features are high selectivity towards the calcium ion and low concentration of the regenerating brine. These characteristics make it compatible with the normal operating range of multiflash plants and very suitable for the above service, when compared with other resins. The optimum coupling conditions of the whole plant, lie between 140 and 150C for the top brine temperature and 2 to 2.5 for the brine concentration factor. In these conditions it is possible to operate with a sea-water resin bed ratio higher than 20.
W84-00281

INVESTMENT COSTS AND ENERGY CONSUMPTION OF THE MSF/FBE IN COMPARISON WITH THE MSF,
Esmil International B.V., Amsterdam (Netherlands).
J. P. P. Tholen.
Desalination, Vol 40, No 3, p 341-345, March 1982. (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, Septebmer 1980), 3 Tab, 3 Fig.

Descriptors: *Desalination, Desalination p¹ants, *Distillation, *Multistage flash, Fluidized bed heat exchanger, Costs, Energy loss.

The use of the MSF process in seawater desalination is broad because of simplicity and reliability and an improvement of this process has been proven in the use of the fluidized bed heat exchanger. The choice of most economical gain ratio of a multistage flash evaporator is very dependent on energy cost, i.e. steam- and electricity cost. Because of lower investment and electricity costs the MSF/FBE has always lower product water cost than the MSF with equal gain ratio.
W84-00282

TRENDS IN THE MAJOR COST COMPONENTS OF MSF DESALTING AND THEIR IMPLICATIONS FOR FUTURE THERMAL DESALTING PLANT,
Binnie and Partners, London (England).
F. C. Wood.
In: Desalination, Vol 40, No 3, p 327-337, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), 4 Tab, 3 Fig, 7 Ref.

Descriptors: *Desalination, Desalination plants, *Distillation, Multistage flash, *Posts, Reverse osmosis.

The capital and operating costs of multistage flash (MSF) seawater desalters have increased drastically over the past decade. Analysis of trends in their major construction and operational costs permits conclusions to be drawn concerning the direction of future developments. If present trends continue, arid, oil-producing countries will require plants of low initial cost, high reliability and ease of operation, rather than new and advanced desalting concepts. On the other hand, oil-importing countries needing desalting must develop less fuel-intensive processes. Although seawater reverse osmosis can meet these needs, a market for dual-purpose plant of high Performance Ratio will persist, particularly where flexibility of operation is required. Hybrid desalters, combining power-using and thermal desalting techniques, will be developed in these countries. Mechanical vapour compression combined with multiple-effect evaporation and MSF feed preheating is one such process.
W84-00283

SEAWATER DESALTING ENERGY REQUIREMENTS AS A FUNCTION OF VARIOUS LOCAL CONDITIONS,
Burns and Roe, Inc., Oradell, NJ.
A. C. F. Ammerlaan.
In: Desalination, Vol 40, No 3, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), p 317-326, 10 Figs.

Descriptors: Desalination, Desalination plants, Vapor compression, Multistage flash, Reverse osmosis, Energy efficiency.

Energy consumption has been of prime concern to the equipment designer. With today's energy costs accelerating at an unprecedented rate, energy efficiency of desalting equipment is getting even more attention. However, local conditions have a considerable effect upon the ultimate selection and design of almost every desalting plant. Once these have been taken into account, by establishing the economic optimum and desired safeguards for the specific local conditions, energy efficiency of the desalting equipment usually is considerably less than the maximum that conceivably could be achieved. One finds that the inventors' and designers' efforts to reduce energy requirements certainly have not been in vain but, on the other hand, can be severely diluted by compromises necessitated by local conditions. Some of these conditions are explored along with their effects upon the energy efficiency of seawater desalting plants for the desalting processes: vapor compression, multistage flash, and reverse osmosis.
W84-00284

COST OF PRODUCING POWER AND WATER IN A COMBINED POWER STATION AND SEAWATER DESALINATION PLANT,
Abu Dhabi National Oil Co. (United Arbab Emirates).
R. Al-Assar, H. E. Homig, and K. Maurath.
In: Desalination, Vol 40, No 3, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), p 311-316, 2 Figs, 1 Tab.

Descriptors: *Desalination, Desalination plants, *Dual purpose plants, Powerplants, Seawater desalination, Electric power costs, *Costs.

The Ruwais Utilities complex is taken as an example to show how the relationship between power and water costs for a dual-purpose plant can be represented in a nomogram. The preparation of such a nomogram for a specific case is simple in principle, but calls for a considerable amount of computing because the cost calculations have to be performed for a large number of variants. This task is greatly facilitated by using suitable EDP programs.
W84-00285

AN EVALUATION OF THE ENERGY REQUIREMENTS OF DESALINATION PROCESSES ON THE BASIS OF THE FUEL-USE PERFORMANCE RATIO,
I. Kamal, and G. F. Tusel.
In: Desalination, Vol 40, No 3, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), p 283-295, 5 Figs, 6 Refs.

Descriptors: *Desalination, Desalination plants, *Reverse osmosis, *Distillation, *Multistage flash, *Multiple effect boiling, *Vertical tube foam evaporation, Single purpose, Dual purpose, Energy requirements, Fuel use performance ratio.

The fuel-use performance ratio is defined as the quantity of water produced, in kg, per 1000 kJ of the heat content of the fuel used for supplying thermal, mechanical and/or electrical energy to the desalination plant. The concept is used to evaluate the energy requirements of the major seawater conversion processes - RO, MSF, multiple effect boiling (as exemplified in the vertical tube foam evaporation process), vapor compression and hybrids of the thermal processes - for three types of plants: (a) single-purpose (water only), (b) dual-purpose (power/water) involving 'power loss' and (c) dual-purpose (power/water) utilizing waste heat. Only distillation systems based on waste heat can compete with the low energy requirements of reverse osmosis.
W84-00286

ENERGY ADVANTAGES OF REVERSE OSMOSIS IN SEAWATER DESALINATION,
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
C. T. Sackinger.
In: Desalination, Vol 40, No 3, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), p 271-281, 8 Figs, 4 Refs.

Descriptors: *Desalination, Desalination plants, *Reverse osmosis, Seawater desalination, Energy, Electric power costs, *Costs.

The very rapid increase in energy costs during the past three years is causing a change in the preferred process technology for seawater desalination. The phase changes, evaporation and condensation, required in the distillation processes make them more energy intensive than the ambient temperature liquid separation that occurs in the reverse osmosis (RO) process. The RO process and how to calculate its energy consumption are described. The RO process requires only 5-7 kWh/cu m of product water compared to 15-16 kWh/cu m required by the most efficient distillation process. The productivity of a large dual purpose electricity/RO water plant is compared to the productivity of a commercially purchased state-of-the-art dual purpose electric/distillation water plant that is currently under construction. The RO potable water productivity is about twice the distillate flow at the same fuel rate.
W84-00287

CONSIDERATIONS OF ENERGY CONSUMPTION IN DESALINATION BY REVERSE OSMOSIS,
UOP, Inc., San Diego, CA. Fluid Systems Div.
A. B. Riedinger, and C. E. Hickman.
In: Desalination, Vol 40, No 3, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), p 259-270, 10 Fig.

Descriptors: *Desalination, Energy consumption, *Reverse osmosis, Feedwater treatment, Osmotic pressure.

The primary factors affecting the energy consumption of a reverse osmosis (RO) plant are considered. These are the osmotic pressure of the feedwater, the feedwater temperature, the water recovery, and the relationship between the water flux and salt flux characteristics of the membrane. In addition, the required permeate quality may have several indirect effects on the energy consumption. Permeate quality standards may impose minimum operating pressures, limit the recovery, and/or require treatment with a full or partial 2nd. stage. As a general rule, the energy required increases with increasing feed salinity and increasing permeate quality. For any given recovery, a single stage system will require less energy than a partial two stage system. However, for a specified permeate quality, a partial two stage system can operate at a higher overall recovery and a lower energy consumption than a single stage system. Energy recovery systems can recover between 50 and 90% of the available energy consumption. Studies have shown that with an energy recovery system, the minimum energy consumption occurs at a first stage recovery of 30 to 35%. Currently, very few energy recovery systems are in use because of their high capital cost, but as energy recovery systems become more available and reliable, they will greatly increase the energy efficiency of RO plants.
W84-00288

DISTILLATION AND REVERSE OSMOSIS ENERGY CONSUMPTION AND COSTS,
Preece, Cardew and Rider, Brighton (England).
N. M. Wade, and M. R. Hornsby.
In: Desalination, Vol 40, No 3, March 1982 (Comprising the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980), p 245-257, 2 Tab, 4 Figs.

Descriptors: *Desalination, Desalination plants, Distillation, Reverse osmosis, Energy, Costs, *Electric power demand.

Energy requirements are compared of single and dual purpose multistage flash distillation with a seawater reverse osmosis (RO) plant. Energy consumptions are given both as heat and power consumptions for distillation and as power consumption for RO. To enable a true comparison to be made these inputs are referred back to the heat inputs from fuel needed at the boiler plant or appropriate thermal power plant. Energy recovery is also considered for reverse osmosis and it is shown that the energy input can be expected to decrease by some 35% for a typical example. Although the prime energy input needed for reverse osmosis is shown to be substantially lower than for dual purpose distillation, the overall costs taking account of capital charges, energy, replacements and other operating costs, are found to be in a band width of about 5% for plants in the range of 5000 to 15000 cu m/day. Reverse osmosis plant water costs are significantly less than distillation if membrane life increases from 3 years to 5 years, particularly with small plant capacities.
W84-00289

AN INTRODUCTORY SURVEY OF ENERGY ASPECTS IN DESALTING PROCESSES,
Aquila Univ. (Italy).
D. Barba.
In: Desalination, Vol 40, No 3, p 227-229 (Summary of the Round Table Conference on the Influence of Thermodynamic and Economic Aspects in Energy Consumption for Water Production during the 7th International Symposium on Fresh Water from the Sea, Amsterdam, September 1980).

Descriptors: *Desalination, Desalination plants, Electric power demand, Costs, *Energy.

A special conference was held dealing with relations between desalting processes and energy to obtain a state-of-the-art review comparing various desalting processes. Discussions are mainly oriented to demonstrate consumption of energy of evap-

oration vs. membrane processes stressing that objective methods of measurement do not exist.
W84-00290

3B. Water Yield Improvement

GEOPHYISCAL EXPLORATION SURVEYS FOR GROUND WATER IN THE SAN PEDRO BASIN, ARIZONA,
Arizona Univ., Tucson. Coll. of Earth Sciences.
J. S. Sumner, and P. F. Halvorson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110808, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Completion Report, August 1983. 24 p, 2 Fig, 2 Tab, 40 Ref. OWRT A-108-ARIZ(1), 14-34-0001-1103.

Descriptors: Geology, *Gravity studies, Subsurface investigations, Model studies, *Arizona, *Geophysical exploration, *Groundwater, San Pedro basin.

To increase knowledge of the subsurface geology in the San Pedro Valley, Southeastern Arizona, several hundred additional gravity measurements were taken in the region. The new gravity values were supplemented by private data donated to this project and to the Arizona Gravity Data Base. The primary purpose of the gravity research was to obtain more information about the thickness and extent of the water-bearing alluvium in the San Pedro Basin. Two-dimensional cross-sectional models of the best gravity profiles were generated. Geologic information, especially in the way of formation density values, was added to the gravity models whenever possible. The gravity station density of the southern part of the study area (upper San Pedro Basin) was such that a three-dimensional subsurface model can be developed. Well data and a general knowledge of the geology in the San Pedro Valley were used to help constraint the variables involved in modeling the gravity data. It appears that a considerable resource of ground water exists in the San Pedro Basin in the area of this study. Approximately 50 x 10 super 6 acre-feet underlie the northern portion between Winkieman and Benson and 100 x 10 super 6 acre-feet south of Benson for a total of 150 x 10 super 6 acre feet. The gravity method has proven to be successful in outlining the concealed bedrock edges of the basin, made obscure by weathering and a soil veneer.
W84-00007

3C. Use Of Water Of Impaired Quality

OPTIMIZATION OF PRIMARY PRODUCTION BY THE HALOPHYTIC ALGA, DUNALIELLA SALINA, IN SALINE WATER,
New Mexico Water Resources Research Inst., Las Cruces.
R. Roubicek, and L. White-Hosford.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113604, Price Codes: A04 in paper copy, A01 in microfiche. Technical Report No 166, April 1983. 53 p, 13 Fig, 10 Tab, 34 Ref. OWRT A-067-NMEX(1), 14-34-0001-2133.

Descriptors: *Algal growth, *Halophyte, Growth rate, *Biomass, *Production, Brackish water, Saline water, Respiration, Osmoregulation, Photosynthesis, *Dunaliella, *Metabolism, Algae.

The industrial cultivation of algal biomass is a very attractive project for both primary and secondary metabolite production. Solar energy conversion via algal cultivation results in yields which can be more than 100 times greater per acre than terrestrial crops. However, algal biomass production has not yet been shown to be economically feasible due to traditional technologies in which algae are grown in large shallow ponds. Because of the low depth of the ponds, an extremely large area is required to build a minimally economical production unit. Many other factors render this process difficult to control. An abundance of saline underground water can be found in arid or semi-arid areas with solar availability. The use of shallow ponds for algal biomass production in these areas enhances the evaporation rate of the water making salinity a limiting factor. For these reasons, the behavior of halophytic algae of the genus Dunaliella and the feasibility of employing submerged cultivation in a photo-bioreactor using brackish and saline media was investigated. Dunaliella salina produces large quantities of glycerol as a osmoregulative response to high concentrations of salts. Dunaliella bardawil, under the same condition produces high concentrations of B-carotene. In the first stage of experimentation the most productive isolates were selected and conditions of maintenance were established. The selected isolates were tested for growth in laboratory shaker experiments and finally laboratory pilot plant experiments were carried out in a 14 liter submerged culture.
W84-00138

ASSESSING BRACKISH WATER FOR GUAYULE RUBBER PRODUCTION,
Arizona State Univ., Tempe. Div. of Agriculture.
T. L. Righetti, and R. A. Backhaus.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113612, Price codes: A02 in paper copy, A01 in microfiche. Water Resources Research Center Completion Report, Univ. of Arizona, Tucson, September 1983. 18 p, 7 Fig, 2 Tab, 13 Ref. OWWR A-116-ARIZ(1), 14-34-0001-2103.

Descriptors: *Guayule, Hydroponics, Parthenium argentatum G., Plant greeding, Plant selection, Salinity solution culture, Water quality, *Brackish water, Rubber production, *Arizona, Tempe, *Plant tolerance.

A screening procedure for salt tolerance in guayule has been developed. Two small scale and one large-scale (100 liter tanks) solution culture screening trials have been completed. Producing 1,200 to 2,000 uniform transplants from germplasm varying in germination time and percentage is cumbersome, but the following procedure has been developed for routine use. Seeds are pregerminated in aerated distilled water then sprouted in flats of peat-vermiculite under an automated mist system. After three weeks seedlings are transplanted into individual containers and grown another three weeks before transplanting into solution culture tanks. Aeration is provided with a Gardner-Denver rotary blower. Salt stresses are gradually implemented over a two-week period. Plants are harvested after ten weeks. A portion of the experiment is not included in the destructive harvest so some seedlings showing striking salt resistance or sensitivity can be maintained for further study. Within strain variability makes it difficult to statistically detect differences among strains. It may be more useful to select tolerant individuals for inclusion in breeding programs than to identify resistant strains. Even with the variability encountered some strain difference are apparent. Guayule strain N396 has shown superior survival when stressed with magnesium chloride and appears to tolerate sodium chloride stress better than other strains. Differences are not due to differing uptake of Ca, K, Mg, or Na.
W84-00139

HUGE SEAWATER PLANT PERFORMS AS PLANNED,
S. L. Matheny.
Oil and Gas Journal, Vol 78, No 27, p 87-88, 92, July, 1980. 3 Fig.

Descriptors: *Seawater, *Desalination plants, Demineralization, Desalination apparatus, Water supply development, Industrial water, Water quality, Water treatment, *Saudi Arabia.

A seawater treatment plant designed to take in a volume of 19 million barrels per day is described. The treated water is employed in injection wells in the Ghawar oilfield, Saudi Arabia. The plant cost about $500 million to construct. The plant went onstream in June 1978. The intake side of the plant is sealed off by a rock wall basin. The seawater first passes through a bar screen which separates out solids larger than 1 inch in diameter. The drum screen, next in line, filters out all particles over 2 mm in diameter. One hundred lb/hr of hypochlorite solution is injected into the stream before it goes into the canal at a chlorine content of about 4 ppm. Supplemental chlorine is added as needed. The chlorinated water passes through four horizontal Baker sand filters. Each deaerator can handle 500,000 b/day at 1 atmosphere pressure. Each deaerating column has 16 trays. The system is designed to deliver injection water of a quality which will not plug the injection wells. (Baker-FRC)
W84-00291

3D. Conservation In Domestic and Municipal Use

IMPACT ON RESIDENTIAL WATER CONSUMPTION OF AN INCREASING RATE STRUCTURE,
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
For primary bibliographic entry see Field 6C.
W84-00100

3E. Conservation In Industry

INDUSTRIAL WATER REUSE VERSUS NET WATER LOSS,
Delaware River Basin Commission, Trenton, NJ.
S. D. Selzer, and P. J. Webber.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111822, Price codes: A05 in paper copy, A01 in microfiche. Completion Report OWR/RU-83/2, U.S. Dept. of the Interior, Bur. Reclamation, Washington, DC, June 1983. 84 p, 4 Fig, 7 Tab, 12 Ref, 2 Append. OWRT C-00079-R(No 0493)(1).

Descriptors: *Water loss, *Consumptive use, *Water reuse, *Industrial water, *Cooling water, Cooling towers, *Delaware River, Evaporation, Heat exchangers, *Dry cooling, *Heat recovery, *Reuse factor, Petroleum industry, Chemical industry, Paper industry, Food industry, Primary metal industry.

Water use and other data of 13 Delaware River Basin industrial plants were examined to determine the impact of increased reuse of water upon consumptive use of water. The plants were of the petroleum, chemical, paper, food, and primary metal industries. The change over time, year 1971 to 1981, of the reuse factor (reuse/withdrawal) was compared to change in consumptive use per unit of product. The reuse factor was increased for 9 plants. The consumptive use per unit of product was decreased for 7, increased for 1, and remained constant for 1 of these plants. The reuse factor was not measurably changed for 4 plants. The consumptive use per unit of product was decreased for 2 and was increased for 2 of the 4 plants. For 86 plants in the Basin, including the 13 discussed above, the combined consumptive use was decreased from 1971 to 1981. Although there were limited quantitative data, none of the 86 appeared to have experienced a decrease in the reuse factor over the 1971-81 decade. Causes for increased reuse have included minimization of water and waste treatment and energy costs. Causes for decreased consumptive use have included increases in dry cooling and heat recovery.
W84-00042

3F. Conservation In Agriculture

THE EFFECT OF MOISTURE STRESS ON CORN PRODUCTION IN THE HIGH PLAINS,
New Mexico State Univ., Las Cruces. Dept. of Agricultural Engineering.
T. W. Sammis, and D. Smeal.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113653, Price codes: A04 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute Technical Report No 171, Las Cruces, June 1983.

73 p, 10 Fig, 26 Tab, 3 Ref, 4 Append. OWRT B-069-NMEX(1), 14-34-0001-0234.

Descriptors: *Corn, *Crop production, Computer model, *Moisture stress, Irrigation, High plains, Crop yield, Evapotranspiration, Simulation, Model studies, Soil moisture.

Evapotranspiration and yield were measured for selected deficit irrigation and nitrogen levels, and the data used to derive the water production function. Nitrogen stress limited yield but did not affect the water production function relationship. However, the water production functions did vary in their intercept between years. These differences may have been due to differences in yearly soil evaporation. The slope of the water production functions of the water use efficiency was the same over years. Corn growth was modeled using a physiologically based model. The model simulated biomass and grain yield under non-moisture stress conditions within 10% of the measured values, and over estimated production as moisture stress increased. Modifications to the model to include the effect of moisture stress on leaf size and the effect of hail damage on corn growth increased the model's predictability, but still the model over estimates corn growth under soil moisture stress conditions. The model did not do a satisfactory job of predicting corn growth when competition between plants was decreased due to the low planting density that occurred in 1982.
W84-00163

SOIL CRUSTING AFFECTS WATER CONSERVATION AND INFILTRATION,
Kansas Water Resources Research Inst., Manhattan.
D. M. Powell, and J. M. Steichen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113695, Price codes: A02 in paper copy, A01 in microfiche. Contribution No 232, March 1983. 24 p, 7 Fig, 8 Tab, 13 Ref, 1 Append. OWRT A-108-KAN(1), 14-34-0001-2118.

Descriptors: *Rainfall infiltration, *Infiltration rate, *Mathematical modcls, *Surface sealing, Tillage, *Crop residue, *Soil crusting, *Kansas, Model studies, *Water conservation.

An infiltration model is developed to include formation of a soil crust under transient conditions. A Soil-Crust Index has been defined and experimentally tested for two Kansas soils. The infiltration model utilizing the Soil-Crust Index was field tested on several tillage practices but for only one soil. The results of the laboratory experiments failed to indicate that the Soil-Crust Index can be applied across soil textures. Additional information is needed, particularly as pertains to high Soil-Crust Index values, before this can be adequately determined. The field experiments indicated that simulated infiltration trials may adequately predict infiltration for different tillage practices provided surface-depression storage can be properly estimated.
W84-00167

CAREFUL CROP PLANNING CUTS STRAIN ON IRRIGATION WATER SUPPLY.
New Zealand Journal of Agriculture, Vol 145, No 6, p 15-16, December, 1982.

Descriptors: *Irrigation efficiency, *Scheduling, Agronomy, Water conservation, *Water demand, Planning, Conservation, *New Zealand.

Careful crop planning can help match irrigation needs with scarce supplies during a drought such as was experienced recently in New Zealand. This is done by selecting crop types with regard to their watering demand pattern and by timing sowing dates so that peak water demands for different areas do not coincide. If a crop plan shows an overextension of water supplies, altering the proportions of crops and/or changing sowing dates can even the water demand. An example illustrates that barley, spring peas, and white clover all need irrigation in early December. Replacing some of these crops with autumn peas (irrigated in mid to late November), linseed (irrigated mid-October), or autumn wheat (irrigated early November) would overcome this problem. Altering sowing dates has little impact in autumn, but in spring a 1 month delay in sowing can postpone the critical growth stage about 1-3 weeks. During hot dry weather the water demand schedule is condensed. (Cassar-FRC)
W84-00170

TRICKLE IRRIGATION VS. NO-IRRIGATION OF FIVE HORTICULTURAL CROPS IN PENNSYLVANIA,
Agricultural Research Service, Shafter, CA. Cotton Research Station.
W. R. DeTar, D. F. Kibler, D. W. Grenoble, R. Daniels, and R. H. Cole.
Transactions of the ASAE, Vol 26, No 1, p 82-86, 1983. 1 Tab, 10 Ref.

Descriptors: *Trickle irrigation, *Crop yield, Irrigation programs, Potatoes, Strawberries, Irrigation, Water supply, Water conservation, Raspberries, Apples, Cantaloupes, *Pennsylvania.

Several irrigation experiments were set up in 1979, 1980, and 1981 on five crops, strawberries, raspberries, potatoes, apples, and cantaloupes, with irrigated vs. non-irrigated treatments being the main point of interest. The trickle irrigation system was found to be a very useful tool for this type of field study in that it provided excellent moisture control and permitted proper randomization and replication within relatively small land areas. Significant yield differences were found only in the 1980 potatoes and the 1980 cantaloupes. In 1980, non-irrigated Norchip potatoes yielded 35% less than irrigated potatoes. A drought in June of 1980 caused the non-irrigated cantaloupes to produce 15.5% less than the irrigated treatment. However, a drought in August of 1981 caused no significant reduction in cantaloupe yield, leading one to conclude that irrigation of cantaloupes is not needed during the 3 weeks just before harvesting. The use of single chambered perforated tubes in every other potato row did not reduce yields, in spite of an obvious lack of uniformity of water application. (Baker-FRC)
W84-00180

ESTIMATING LOSSES FROM A ROTATING-BOOM SPRINKLER,
Agricultural Research Service, Morris, MN. North Central Soil Conservation Research Center.
A. S. Dylla, and H. Shull.
Transactions of the ASAE, Vol 26, No 1, p 123-125, 1983. 1 Fig, 1 Tab, 13 Ref.

Descriptors: *Sprinkler irrigation, *Evaporation, Water loss, Irrigation practices, Irrigation, Wind drift, Wind, Mathematical equations, Estimating equations.

Evaporation and wind drift losses from a moderate sized sprinkler system operated in Minnesota were investigated to provide better information for designing and managing irrigation systems in a windy, humid and temperate climate. Spray evaporation and wind drift losses were determined from the operating system by measuring differences between the water pumped through the system and the water reaching vegetative and soil surfaces in the sprinkler pattern area. A grid array of sprinkler water collectors was used. Water loss amounts and climatic data for 31 sprinkler runs were used to calculate a multiple linear regression loss estimating equation. It was concluded that the difference between the metered volume of water pumped through an irrigation system and that reaching soil and crop surface, as calculated from grid-arrayed collector cans, was a reasonable estimate of the combined spray evaporation and wind drift losses. Although such losses are related to the evaporative conditions of the atmosphere during sprinkling, it is not prudent to fail to recognize that the losses are also related to the peculiar water discharge. For calculating the percent combined evaporation and wind drift losses from a large rotating-boom sprinkler system operating in a semi-humid temperate climate, the equation given is sufficiently accurate for irrigation planning and scheduling and determining gross water requirements. (Baker-FRC)
W84-00182

ENERGY AND WATER REQUIREMENTS FOR SUBIRRIGATION VS. SPRINKLER IRRIGATION,
Earlham School of Religion, Richmond, IN.
F. C. Massey, R. W. Skaggs, and R. E. Sneed.
Transactions of the ASAE, Vol 26, No 1, p 126-133, 1983. 7 Fig, 9 Tab, 22 Ref.

Descriptors: *Subsurface irrigation, *Sprinkler irrigation, *Energy, Model studies, Irrigation programs, Irrigation practices, Seepage, Water loss, *North Carolina.

Water and energy requirements of subirrigation and sprinkler irrigation systems for three sites in eastern North Carolina were determined. The specific objectives of the study were to obtain soil input data and design both subirrigation and sprinkler irrigations; to simulate the operation of the irrigation systems over several years of climatological record to evaluate the performance of each system; and to evaluate the amount of water and energy required, on the average, for comparable sprinkler irrigation and subirrigation systems in humid regions. It was concluded that subirrigation required more water than sprinkler irrigation for the cases considered. Sprinkler irrigation required 4 to 8 cm less water on the average than the subirrigation when seepage losses and efficiencies were taken into account. When a surface water supply was assumed, subirrigation required only about 9 and 6% of the energy required for the 340 and 690 kPa sprinkler irrigation systems, respectively. When a deep water supply was used, subirrigation offered a 20% savings in the amount of energy required for the 340 lPa system under sandy loam soil conditions. The climatic conditions had an effect on the volume of water pumped and therefore on the total energy requirements. Differences in energy requirements for the subirrigation and sprinkler irrigation systems at Jacksonville, Florida and Indianapolis, Indiana, were about the same as given in the study for North Carolina conditions. (Baker-FRC)
W84-00183

IRRIGATION UNIFORMITY EFFECT ON LAND AND WATER ALLOCATION,
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
I. Seginer.
Transactions of the ASAE, Vol 26, No 1, p 116-122, 1983. 6 Fig, 6 Ref.

Descriptors: *Irrigation, *Water supply, Water conservation, Crop yield, *Water distribution, Mathematical studies, Mathematical equations, Water allocation.

The problem of allocating land and water to a single irrigated crop is treated, with emphasis on the effect that water distribution uniformity should have on the decisions to be taken. Eventually considerations of uniformity should be incorporated in more complex allocation problems. Analytical solutions are developed for simple production and distribution functions. Three general situations become apparent: (a) limiting water, when all water should be used for irrigation; (b) limiting land, when all available land should be irrigated; and (c) limiting crop, when it is not justified to irrigate the given crop. For any given production function, the optimal seasonal water application may vary widely, depending on the price system, the availability of land and water, and the uniformity of water application. The returns for improving the uniformity coefficient are affected strongly by the curvature of the production function, but only slightly by the relative availability of land and water. (Baker-FRC)
W84-00184

DRIP IRRIGATION APPLICATION EFFICIENCY AND SCHEDULES,
Hawaii Univ., Honolulu. Dept. of Agricultural Engineering.
I. P. Wu, and H. M. Gitlin.

Transactions of the ASAE, Vol 26, No 1, p 92-99, 1983. 9 Fig, 1 Tab, 10 Ref.

Descriptors: *Irrigation practices, *Application rates, Hydraulics, Irrigation, *Drip irrigation, Efficiency, Irrigation programs.

A drip irrigation system has a potential for a higher application efficiency than the other irrigation systems such as furrow and sprinkler. Drip irrigation application efficiency can be estimated for all types of emitter flow profiles caused by hydraulic design. A relationship was determined between drip irrigation application efficiency and percent of deficit for design criteria for 10% and 20% emitter flow variation. Drip irrigation application efficiency can be estimated for emitter flow variations stemming from both hydraulics and manufacturing. The irrigation time can be calculated based on the total water requirement, the allowable deficit, the actual total discharge, and the irrigation application efficiency. The emitter flow variation in a drip irrigation design or any nonuniformity of emitter flow will result in an extra amount of irrigation to meet the water requirement for the whole field. If any percent of deficit is allowed, the extra amount of irrigation will be reduced. A water saving of 10-30% can be made by allowing a 3-6% deficit in the irrigation scheduling. The allowable deficit, however, depends on the crop tolerance to soil moisture deficiency. The assumption that the total emitter flow variation is a normal distribution has not been verified using laboratory data or field measurements. However, the contribution of hydraulics to the total variation is only a small portion, while a larger portion is contributed by manufacturing variation which is normally distributed. Deficit irrigation increases water application efficiency and can achieve an application efficiency of 100%. (Baker-FRC)
W84-00192

DESIGN PROCEDURE OF SPRINKLING LATERALS: THE MATHEMATICAL BACKGROUND OF A COMPUTERIZED AID: COMMENTS,
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
G. Oron.
Agricultural Water Management, Vol 5, No 4, p 375-377, December, 1982. 3 Ref.

Descriptors: *Design criteria, *Mathematical equations, *Sprinklers, Sprinkler irrigation, Sprinkling, Computers, Irrigation.

Methodology used in the procedure for sprinkling lateral design by Pleban and Amir in the above titled paper, published in Agriculture Water Management, Vol 3, p 269-278, 1981, is praised, but comments are presented on the equation used to describe the flow rate. The original authors express the flow rate through the sprinkler by a polynomial third degree, and had used a polynomial expression for the discharge-pressure head function of emitters. The current author would have preferred the use of an exponential expression. It was out of practical considerations only that the original authors decided against the use of an exponential expression and used instead the polynomial one. It is noted that without changing the design procedure either expression could be used where it is practically justified. (Baker-FRC)
W84-00349

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

OPTIMAL OPERATION OF A MULTIPLE RESERVOIR SYSTEM,
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. A. Marino, and H. A. Loaiciga.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111665, Price codes: A14 in paper copy, A01 in microfiche. California Water Resources Center Completion Report, University of California, Davis, September 1983. 298 p, 27 Fig, 75 Tab, 86 Ref. OWRT-A-088-CAL(2).

Descriptors: *Reservoir operation, *Optimization, *Model studies, Energy, Streamflow, Multiobjective planning, *California, Central Valley Project, *Multiple reservoir systems.

A methodology to obtain optimal reservoir operation policies for a large-scale reservoir system is presented. The model maximizes the system annual energy generation while satisfying constraints imposed on the operation of the reservoir network. The model incorporates the stochasticity of river flows and keeps future operating schedules up-to-date with the actual realization of those random variables. It yields medium-term (one-year ahead) optimal release policies that allow the planning of activities within the current water year, with the possibility of updating preplanned activities to account for uncertain events that affect the state of the system. The solution approach is a sequential dynamic decomposition algorithm that keeps computational requirements and dimensionality problems at low levels. The model is applied to a nine-reservoir portion of the California Central Valley Project and the results are compared with those from conventional operation methods currently in use, showing that the use of the model can improve the levels of energy production (about 30% increase) while the optimal release policies meet satisfactorily all other functions of the reservoir system. Sensitivity analysis is conducted to assess the optimality of the solutions and several alternative formulations of the model are developed and tested, the results showing the robustness of the optimal policies to the choice of model. (Snyder-California)
W84-00026

PREDICTING DAILY IRRIGATION PROJECT DIVERSIONS,
Idaho Univ., Moscow. Dept. of Agricultural Engineering.
S. Kim, J. R. Busch, and K. H. Yoo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111855, Price codes: A05 in paper copy, A01 in microfiche. Idaho Water and Energy Resources Research Institute Completion Report, Moscow, October 1983. 72 p, 13 Fig, 3 Tab, 20 Ref, 3 Append. OWRT A-074-IDA(1), 14-34-0001-2114.

Descriptors: Irrigation systems, *Irrigation districts, Water management, *Irrigation practices, Water demand, *Diversions, Prediction, *Idaho.

The purpose of the research was to develop and apply methods for predicting daily irrigation diversions. Two types of models were developed to effectively predict diversions one day in advance and were applied to two large irrigation projects located in southeastern Idaho. The types of procedures developed and tested were (1) physical and (2) statistical procedures. In addition, variables related to predicting diversions were presented and their relationships described. The physical model developed was designed to accurately represent the physical processes of water conveyance and use in an irrigation system. Required inputs included crop consumptive use and irrigation efficiencies in conjunction with time variables such as irrigation interval, irrigation application time and traveling time in the system. Results from the physical model indicated that more data would be necessary for accurate predictions in addition to updating procedures to account for seasonal variations within the system and management. Statistical models were developed using multiple regression techniques. Required inputs included evapotranspiration, precipitation, weekly variation of water use, previous diversion, and dummy variables used to account for monthly and seasonal variations of soil moisture management. Predictions from the statistical model followed actual diversions quite closely for three irrigation seasons. It was concluded that the statistical models were superior to the physical modeling approach for predicting irrigation diversions.
W84-00045

A HEURISTIC SOLUTION PROCEDURE FOR A JOINT RESERVOIR CONTROL-CAPACITY EXPANSION PROBLEM,
National Research Inst. for Mathematical Sciences, Pretoria (South Africa).
M. Sniedovich, and P. A. Nielsen.
Water Resources Research, Vol 19, No 1, p 15-20, February, 1983. 7 Tab, 6 Ref.

Descriptors: *Reservoir operation, *Water supply systems, Optimization, Planning, Stochastic process, *Heuristic solution, Procedure.

The reservoir control-capacity expansion problem is treated by first solving a modified stochastic problem, then using simple heuristic methods to transform the optimal stochastic capacity expansion policy into a deterministic policy. This procedure avoids separating the problem into two sections and does not rely on steady state conditions. Since an optimal solution cannot be guaranteed, a procedure for constructing an upper bound for the optimal solution is given. This upper bound is used to evaluate the performance of the deterministic solutions and to determine whether the heuristic solution is nearly optimal. A numerical example illustrates the method. (Cassar-FRC)
W84-00106

ASYMPTOTIC DISTRIBUTION OF THE MAXIMUM DEFICIT WITH CORRELATED, PARTIALLY REGULATED OUTFLOWS,
Geological Survey, Lakewood, CO. Water Resources Div.
B. M. Troutman.
Water Resources Research, Vol 19, No 1, p 104-108, February, 1983. 4 Fig, 14 Ref.

Descriptors: *Flow regulation, *Reservoir releases, Reservoir operation, Markov process, Mathematical studies.

The asymptotic distribution of the maximum accumulated deficit with partially regulated, Markov-dependent net outflows having a Bernoulli distribution is derived, and the distribution for independent, continuous outflows is presented. It is demonstrated that under partial regulation the maximum deficit behaves as log n, where n is the length of the series; this is to be contrasted with the n to the 1/2 power behavior exhibited by fully regulated outflows. Also, as would be expected, the presence of correlation tends to increase the magnitude and variability of the maximum deficit. (Author's abstract)
W84-00107

DAILY OPERATION OF A MULTIPURPOSE RESERVOIR SYSTEM,
Southern Illinois Univ. at Carbondale. Dept. of Geology.
H. Yazicigil, M. H. Houck, and G. H. Toebes.
Water Resources Research, Vol 19, No 1, p 1-13, February, 1983. 11 Fig, 4 Tab, 13 Ref.

Descriptors: *Reservoir operation, *Model studies, *Decision making, Reservoir releases, Multipurpose reservoirs, Green River Basin, *Kentucky.

The Green River Basin Operation Optimization Model (GRBOOM) was designed to aid reservoir operators in making decisions for daily, real-time operations and for long-term operating guidelines. The Green River Basin, Kentucky, consists of four flood control reservoirs; recreation and low-flow augmentation are secondary objectives. The linear program model tries to minimize the sum of all daily penalties over the operating horizon (usually 1-5 days). Constraints include reservoir mass balance, storage zone, control station mass balance, flow zone, and release rate constraints. Simulation of reservoir operation using historical data for April 29, 1970, and for the 87-day period December 26, 1969-March 10, 1970, produced model-recommended operations that were 25.7% and 45.8%, respectively, more efficient than actual operations. The model is flexible and easily modified to allow experimentation with new operating regulations or policies. Results are produced in graphical form, if desired. (Cassar-FRC)
W84-00109

IMPROVEMENTS TO THE TRANSITION DEFINITION FOR THE LLOYD MODEL OF DISCRETE STATE STORAGE WITH CORRELATED INFLOWS,
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
D. G. Doran.
Water Resources Research, Vol 19, No 1, p 69-76, February, 1983. 8 Fig, 30 Ref.

Descriptors: *Reservoir storage, *Storage, Model studies, Lloyd model.

The transition probability matrices which result from the Lloyd model of storage are very large, and when these matrices are constrained to be of manageable size, loss of accuracy in the performance of the model results. A description is given of an extension to a previous technique, the divided interval scheme, which makes possible the practical use of Markov chain analysis with given inflow distributions to provide comparatively accurate results in a probabilistic account of reservoir behavior. The extension is applied specifically to the Lloyd model of storage for single reservoirs, and the results of such analyses are obtained with modest computer storage requirements. (Author's abstract)
W84-00110

REAL-TIME RESERVOIR SYSTEM OPERATION,
Purdue Univ., Lafayette, IN. Water Resources Research Center.
M. H. Houck.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113661, Price codes: A04 in paper copy, A01 in microfiche. Technical Report No 151, September 1983. 42 p, 7 Fig, 2 Tab, 10 Ref. OWRT B-125-IND(2), 14-34-0001-1223.

Descriptors: *Reservoir operation, *Optimization, Flood routing, Streamflow forecasting, *Kentucky, Model studies, *Real-time operation, Goal programming, Objective function, Chance constrained programming, Green River Basin, Nonlinearity.

Several different optimization models developed by researchers at Purdue University for real-time, short term reservoir system operation are described. The models include: an optimization model constructed specifically for a multi-reservoir, multipurpose system in Kentucky; a goal programming model that requires less information than most other models yet yields equivalent or better results; a chance constrained model that explicitly considers errors in streamflow forecasts in the operating environment; and a balancing model that uses cumulative distribution functions to maintain a balance between storage, release, and any other characteristic of the operation. The description of each model and comparisons between models are brief but references to the relevant literature are provided.
W84-00164

POLDERS: AN ANCIENT APPROACH TO LAND RECLAMATION,
Rijkswaterstaat, The Hague (Netherlands).
A. Volker.
Nature and Resources, Vol 18, No 4, p 2-13, October-December, 1982. 6 Fig, 6 Ref.

Descriptors: *Polders, *Land reclamation, *Drainage, Agriculture, Developing countries, Deltas, Water management, Coastal engineering, Marshes, Hydraulic engineering, Netherlands, Japan, Tidal flats, Flood protection, History, Economic aspects, Irrigation, Risks.

Polders are a sophisticated form of land reclamation involving flood protection by embankment construction, water course diversion, or upstream flood control. Control of the water levels inside the polders produces land with high agricultural potential. Lands reclaimed by polders are level, often with heavy soils, and have a high water table. They may be formed along sea coasts, from coastal and inland marshes and lakes, in river valleys and by drying up to tidal inlets and lagoons. Some of the deepest polders are 6-10 m below mean sea level. Land subsidence from excessive groundwater abstraction is handled by polder construction. The deeper polders pose a risk to lives and property in case of unusually high water or embankment failure. Therefore, valuable and well-populated polder lands are designed for protection against a 10,000 year sea flood and a 1,000-3,000 year river flood. Warning systems, information programs, a backup line of defense, and drainage arrangements are also necessary. Drainage of polders should be accomplished by gravity if possible, using tidal variations, a lower river reach, or pumping. Polder-type retention basins were used for agriculture by the Egyptians 5000 years ago and by the Sumerians over 3000 years ago. The first Europeans to reclaim land by poldering were the Etruscans, 2500 years ago. In recent times the Netherland and Japan have been most active in polder construction, beginning independently in the late 16th century. Asia has the largest polder acreage, mainly in India and China. In Europe, coastal areas, lake and river deltas, and marshes have been reclaimed. Relatively few polders have been constructed in Africa. Total world polder area is on the order of 10-50 million ha. Future polder construction is expected to be concentrated in developing countries, especially near large cities. (Cassar-FRC)
W84-00169

PIPE DRAINAGE OF HEAVY SOILS: A FIELD EVALUATION,
Soil Conservation Service, Lincoln, NE.
P. N. Walker, and J. D. Wells.
Transactions of the ASAE, Vol 26, No 1, p 112-115, 122, 1983. 7 Tab, 5 Ref.

Descriptors: *Drainage, *Permeability coefficient, *Illinois, Subsurface drainage, Pipes, Irrigation.

Field effective hydraulic conductivities and drainable porosities were determined and drain spacings were recommended based on specified rates of water table fall. A group of 60 Illinois soils were selected for possible evaluation. Five were studied at sites where subsurface drain pipe systems had been installed previous to the study. Plots were irrigated to bring the water table to the soil surface. Irrigation was stopped, and then water table depth and drain flow measurements were made periodically until the water table midway between drains was at a depth of 300 mm. Drainable porosities, hydraulic conductivities, and recommended pipe drain spacings were computed. It was concluded that the average measured drainable porosities for Bonnie, Bryce, Darwin, Piopolis, and Wabash soils ranged from 0.0340 to 0.0483. The field effective hydraulic conductivities ranged from 19.0 to 63.2 mm/h. Only Bonnie had values with USDA published ranges; the other soils had higher measured values. The recommended drain spacings were: Bryce, 24.2 m; Bonnie, 13.9 m; Wabash, 12.8 m; Darwin, 10.8 m; and Piopolis, 13.1 m. (Baker-FRC)
W84-00191

4B. Groundwater Management

SINGLE LOCATION DOUBLET WELL TO REDUCE SALT-WATER ENCROACHMENT: PHASE I - NUMERICAL SIMULATION,
Texas Water Resources Inst., College Station.
D. L. Reddell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110873, Price codes: A04 in paper copy, A01 in microfiche. Technical Report No TR127, September 1983. 43 p, 6 Fig, 89 Ref. OWRT A-051-TEX(1), 14-34-0001-2146.

Descriptors: *Well doublet, Groundwater, *Numerical models, *Saline water encroachment, Well construction, *Simulation, Model studies, Water wells.

C. E. Jacob received patents in 1965 for a single location well doublet that would produce fresh water overlying salt-water without upconing of the heavier salt-water and pollution of the freshwater zone. No known evaluation of the concept or development of design criteria has been accomplished. In this study, a finite difference radial fllow model was developed to determine groundwater velocities and salt concentration as a function of time and space. This model was verified and is available for evaluating design criteria for Jacob's single location well doublet. Initial runs with the model indicate that the concept has potential, particularly in aquifers with clay lenses in the salt-water zone. Additional runs with the model will be needed to fully establish the design criteria necessary for Jacob's single location well doublet.
W84-00014

AN EIGENVALUE NUMERICAL TECHNIQUE FOR SOLVING UNSTEADY LINEAR GROUNDWATER MODELS CONTINUOUSLY IN TIME,
Servicio Geologico de Obras Publicas, Madrid (Spain).
For primary bibliographic entry see Field 2F.
W84-00083

EFFECT OF PUMPED-WELL IRRIGATION AND DRAINAGE ON THE MELIORATION OF SALT-AFFECTED SOILS,
Academia Sinica, Nanjing (China). Nanjing Inst. of Soil Science.
Y. Wen-Rui, and W. Zun-Qin.
Soil Science, Vol 135, No 1, p 47-53, 1983. 2 Fig, 3 Tab, 4 Ref.

Descriptors: Soil properties, *Salinity, *Soil treatment, Drainage, Irrigation, *China, Groundwater, Groundwater management, *Saline soils.

In recent years benefits have been derived from well irrigation and drainage which were adopted for the improvement of salt affected soils in China. Well irrigation can simultaneously lower the groundwater level, leach salts downward from the soil, alleviate the harmful effects of flooding, and promote the salt-leaching effect of natural precipitation in areas where the groundwater is fresh or contains few minerals. Extraction and drainage of highly mineralized groundwater by wells can control the groundwater level and replenish the groundwater layer by irrigation with fresh water diverted from rivers in areas where the groundwater is highly mineralized. This will accelerate salt leaching from soil and prevent secondary salinization of the soil. However, ditch drainage cannot be replaced by well drainage, and usually a combination of the two should be adopted to improve soil quality. Three major patterns of well application for the improvement in soil quality in use in China are: a combination of well irrigation and well drainage in regions where the groundwater is fresh or contains only small amounts of minerals; a combination of deep and shallow wells in regions that have mineralized groundwater; and shallow well drainage in regions of highly mineralized groundwater. (Baker-FRC)
W84-00194

4C. Effects On Water Of Man's Non-Water Activities

IMPROVED METHODS AND GUIDELINES FOR MODELING STORMWATER RUNOFF FROM SURFACE COAL MINED LANDS,
Kentucky Water Resources Research Inst., Lexington.
M. E. Meadows, and G. E. Blandford.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111731, Price codes: A06 in paper copy, A01 in microfiche. Research Report No 147, September 1983. 141 p, 21 Fig, 18 Tab, 64 Ref. OWRT B-069-KY(1), 14-34-0001-0222.

Descriptors: *Stormwater runoff, *Strip mines, Mathematical models, *Hydrologic models, *Synthetic hydrology, *Small watersheds, *Model studies, Simulation, Curve number, Unit hydrographs,

Kinematic runoff, Green-ampt infiltration, Finite element, Modified Newton-Raphson iteration, Excess rainfall pattern.

The investigations, developments and guidelines for several hydrologic modeling strategies are presented. Investigations were conducted to determine appropriate event curve numbers for surface mined disturbed watersheds; and performance of four synthetic unit hydrograph models (SCS curvilinear, SCS single triangle, Williams and TVA double triangle) on 38 USDA experimental watersheds in 14 physiographic provences using in excess of 270 events. A second test using only the SCS curvilinear unit hydrograph on 11 small watersheds and 48 events was conducted to investigate the excess rainfall simulated with the curve number model. A procedure for developing a unit hydrograph using the time area method and two parameter gama distribution is presented for ungaged watersheds or watersheds undergoing land use changes. The development of a coupled explicit finite difference Green and Ampt infiltration-implicit finite element kinematic water model is presented. The deterministic overland flow model includes a variable width which is essential for the accurate modeling of the watershed geometry. Both impervious and pervious watershed simulations are presented for the deterministic overland flow model.
W84-00033

A DECISION MODEL TO PREDICT SEDIMENT YIELD FROM FOREST PRACTICES,
National Forests in North Carolina, Asheville.
R. G. Burns, and J. D. Hewlett.
Water Resources Bulletin, Vol 19, No 1, p 9-14, February, 1983. 3 Fig, 1 Tab, 11 Ref.

Descriptors: *Sediment yield, *Model studies, *Forest management, Mathematical equations, Estimating equations, Decision making, Erosion, Erosion control, Forestry, *Georgia.

Forest managers need to predict sediment yield to perennial streams following various forest land operations in order to choose among best management practices. The universal soil loss equation (USLE) is not directly applicable to forest operations due to the heterogeneous soil surface conditions left by harvesting, site preparation, and planting. A sediment hazard index is proposed, to be based on the amount of exposed mineral soil and its proximity to streams. The model offered includes rainfall erosivity, soil erodibility, and average land slope, together with the index W. A paired watershed experiment in the central Georgia Piedmont was used to estimate parameters in the model. The experimental basin, 80 acres, was clearcut, drum roller chopped twice, and planted by machine. The standard error of estimate of the sediment yield was computed to be about 50 lb/ac per sampling period for four months. Use of Williams' erosivity index reduced the standard error to 33 lb/ac. It is suggested that the equations presented predict conservatively high for the normal range of expected rainfalls, but probably low under extreme rainfall. (Baker-FRC)
W84-00099

IMPACTS OF SILVICULTURE ON FLATWOODS RUNOFF, WATER QUALITY, AND NUTRIENT BUDGETS,
Florida Univ., Gainesville. Dept. of Forest Hydrology.
H. Riekerk.
Water Resources Bulletin, Vol 19, No 1, p 73-79, February, 1983. 4 Fig, 4 Tab, 16 Ref.

Descriptors: *Water quality, *Runoff, *Forest management, Hydrology, Silviculture, Flatwoods, Coastal areas, *Florida, Rainfall-runoff relationships, Nutrients.

Information is given on hydrology, water quality, and nutrient budgets for the first three years of a study on forest watersheds isolated by roads in poorly drained flatwoods of Florida. After 12 months of baseline calibration the forest in one watershed was harvested and regenerated with minimum disturbance, in the second watershed with maximum disturbance from common practices, and in the third watershed left intact as a control. Water yields from the maximum treatments increased a significant 250%, while that from the minimum treatments increased 117% as compared to the control. Weed vegetation remaining after the minimum treatment continued significant water use. The water yield increases lasted only for one year. Water quality was reduced by both treatments, with the most effect immediately after the maximum disturbance. Absolute levels of suspended sediments, potassium, and calcium remained relatively low. The maximum treatment caused significant changes in net cation balances only for one year. The information demonstrated relatively little effect of silvicultural practices in flatwoods on water quality as compared to data from upland forests. Water yield increases may be manipulated by the degree of harvest and weed control practices. (Baker-FRC)
W84-00101

ASPEN CLEARCUTTING INCREASES SNOWMELT AND STORM FLOW PEAKS IN NORTH CENTRAL MINNESOTA,
North Central Forest Experiment Station, Grand Rapids, MN. Forestry Sciences Lab.
E. S. Verry, J. R. Lewis, and K. N. Brooks.
Water Resources Bulletin, Vol 19, No 1, p 59-67, February, 1983. 5 Fig, 3 Tab, 36 Ref.

Descriptors: *Clearcutting, *Flood control, *Forestry, Aspen, Logging, Forest management, Watersheds, *Minnesota, Snowmelt, Rainfall-runoff relationships, Runoff, Storms, Rainfall.

An 18-year paired watershed study of rainfall and snowmelt response to clearcutting the upland part of an upland-peatland watershed in north central Minnesota is described. During the first year of this study one-half of the watershed was clearcut resulting in a 31% increase in annual water yield, but a 35% reduction in the size of snowmelt peak discharge. The nine-year response of peak discharge, storm flow volume, and timing of peak discharge following clearcutting are reported. Both snowmelt and rainfall runoff events are evaluated. Storm flow volumes from rain during the first two years increased as much as 170% but declined to preharvest volumes in the third year. Snowmelt volumes did not change significantly. Snowmelt peak discharge occurred about four to five days earlier after clearcutting, but the timing of storm flow from rainfall was not changed. Snowmelt peaks remained above precut size for nine years after clearcutting on the area undergoing natural regeneration to aspen saplings. Partial cutting - up to about one-half of the watershed - reduced peak snowmelt discharge because melt was desynchronized in cleared and forested parts. Clearing more than 2.3 of the watershed caused snowmelt flood peak size to double during the years with snow packs in excess of seven inches of water that remained until a day when temperatures exceeded 60 degrees F. (Baker-FRC)
W84-00103

4D. Watershed Protection

SOIL EROSION CONTROL ON OWNER-OPERATED AND RENTED CROPLAND,
Missouri Univ.-Columbia. Dept. of Agricultural Economics.
D. E. Ervin.
Journal of Soil and Water Conservation, Vol 37, No 5, p 285-288, September/October, 1982. 3 Tab, 19 Ref.

Descriptors: *Erosion control, *Conservation, Farming, *Land management, Erosion, Management, Decision making, *Missouri, *Soil erosion.

Data from Monroe County, Missouri, are used to demonstrate that there is less erosion control on rented cropland than on cropland operated by the owner. Effective erosion control on rented cropland, therefore, will require special features in new conservation programs, such as differential cost-sharing provisions for tenants. The inclusion of a cost sharing program for erosion control in the original lease agreement appears to be an important element. How to promote this type of lease should be an important area of study for state and federal soil conservation agencies. An important first step would be to educate landlords and tenants about the potential benefits of conservation practices an provsions that can be put into a lease. Conservation tillage and contour farming would be significant factors in alleviating the erosion problem. (Baker-FRC)
W84-00020

MODELING SURFACE AND SUBSURFACE STORMFLOW ON STEEPLY-SLOPING FORESTED WATERSHEDS,
Kentucky Water Resources Research Inst., Lexington.
P. G. Sloan, I. D. Moore, G. B. Coltharp, and J. D. Eigel.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111723, Price codes: A09 in paper copy, A01 in microfiche. Research Report No 142, July 1983. 182 p, 75 Fig, 8 Tab, 90 Ref, 3 Append. OWRT A-085-KY(1), 14-34-0001-1119(FY81), 14-34-0001-2119(FY82).

Descriptors: *Forest watershed, Forest hydrology, Mathematical models, Model testing, Subsurface flow, Subsurface water, Runoff, *Surface flow, Model studies, *Kentucky, Robinson Forest, *Rainfall-runoff relationships, Macropore flow, *Stormflow, Watershed models, Process models.

A simple conceptual rainfall-runoff model, based on the variable source area concept, was developed for redicting runoff from small, steep-sloped, forested Appalachian watersheds. Tests of the model showed that the predicted and observed daily discharges were in good agreement. The results demonstrated the ability of the model to simulate the 'flashy' hydrologic behavior of these watersheds. Five subsurface flow models were evaluated by application to existing data measured at Coweeta on a reconstructed homogenious forest soil. The five models were: Nieber's 2-D and 1-D finite element models, the kinematic wave equation and two simple storage models developed by the authors, the Boussinesq and kinematic storage models. All five models performed reasonably well on this homogeneous soil. The coupled infiltration model had a large effect on the simulation results. The cost of running the computer models and the computer memory requirements increased as their complexity increased. Field soil-water and precipitation measurements were made on a small test plot in Robinson Forest, in eastern Kentucky. These data were used to calculate runoff during four precipitation events and to test three of the subsurface flowmodels on a natural watershed. The simple kinematic storage model performed the best. Flow from the test plot was dominated by macropore flow during storm events, and by flow through the soil matrix during baseflow or recession periods. No surface runoff was observed on the test plot during the period of field observations, except on saturated near-channel source areas.
W84-00032

CLIMATOLOGICAL WATERSHED CALIBRATION,
Forest Research Inst., Kepong (Malaysia).
A. R. H. Nik, R. Lee, and J. D. Helvey.
Water Resources Bulletin, Vol 19, No 1, p 47-50, February, 1983. 2 Fig, 3 Tab, 5 Ref.

Descriptors: *Precipitation, *Streamflow, *Forest management, Water resources development, Water supply, Water quality, Climate, Watersheds, Evaporation, *West Virginia, Appalachian Mountains, Mountains.

The hypothesis that climatic data can be used to develop a watershed model so that streamflow changes following forest harvest can be determined was investigated. Variables which were measured included precipitation, daily maximum and minimum temperature, and concurrent relative humidity. Computed variables included humidity deficit, saturated vapor pressure, and ambient vapor pressure. The high degree of correlation

between annual precipitation and discharge suggests a linear relationship and implies similar watershed storages among hydrologic years. Thus annual discharge must be influenced more by seasonal factors such as precipitation and evaporative demand than by gross year to year differences in soil water storage. Moreover, whereas annual stream flow totals or averages are relatively steady, seasonal patterns of streamflow and the climatic variables of temperature and humidity deficit are obviously cyclic. This points directly to a deterministic relation between evaporation and streamflow and suggests the need for some adjustment to achieve functional synchronization of the seasonal cycles of precipitation and streamflow. It is concluded that climatological calibration appears to be a viable approach under special circumstances, such as when only one watershed is available for study. However, the paired watershed approach is expected to remain the preferred method for determining the effects of forest management on the water resource because of its simplicity and accuracy. (Baker-FRC)
W84-00095

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

INVESTIGATION OF SURFACE WATER FOR CONTAMINATION WITH PSEUDORABIES VIRUS IN RUNOFF FROM PSEUDORABIES QUARANTINED NEBRASKA SWINE PRODUCTION AREAS,
Nebraska Univ.-Lincoln. Dept. of Veterinary Science.
C. L. Kelling.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110774, Price codes: A02 in paper copy, A01 in microfiche. Nebraska Water Resources Center Completion Report, September 1983. 10 p, 3 Tab, 24 Ref. OWRT A-071-NEB(1), 14-34-0001-2129.

Descriptors: *Animal diseases, *Viruses, Water pollution sources, Surface runoff, Waste disposal, Assay, Water analysis, Nebraska, *Pollutant identification, Molecular filtration, Pseudorabies virus.

The objective was to develop methods to concentrate water samples and quantitate virus and to apply the techniques to virological assay of storage ponds, lagoons, waste disposal sites and surface water runoff from swine production areas for contamination with pseudorabies virus. Molecular filtration has been used to concentrate pseudorabies virus (PRV; Herpevirus susis) from six liters of saline or water. Essentially all of the PRV added to the six liters of fluid was concentrated in 100 ml of filtration retentate. Inclusion of a cellulose acetate filter in the system effectively removed particulate matter without reducing the viral titer of the filtrate. The ability to remove particulate matter from water renders the system applicable to concentration of surface water runoff for assay for the presence of PRV. The capability to concentrate PRV from larger volumes of water will provide technology to assay runoff water from PRV quarantined swine production units for the presence of virus.
W84-00004

OLIGOCHAETES AS INDICATORS OF POLLUTION IN THE HUMBER ESTUARY, WITH SPECIAL REFERENCE TO TUBIFICOIDES BENEDENI,
Anglian Water Authority, Huntingdon (England). Lincolnshire River Div.
B. E. Barnett.
Environmental Pollution, Series A, Vol 30, No 4, p 277-291, 1983. 7 Fig, 1 Tab, 16 Ref.

Descriptors: *Water pollution effects, *Species diversity, *Oligochaetes, *Tubificids, *Bioindicators, *Distribution patterns, Industrial wastes, Indicators, Species composition, Domestic wastes, Coastal waters, Estuaries, Humber Estuary, *England.

Two intertidal surveys were conducted to examine the geographical and tidal distribution, abundance and numerical dominance of major oligochaete species in relation to the potential role of these organisms as indicators of pollution in the Humber Estuary, United Kingdom. Results showed that Tubifex costatus and Tubificoides benedeni were dominant species according to the Shannon-Weaver diversity index. Although data concerning oligochaete distribution and abundance must be interpreted with care, T. benedeni appears to be a valid indicator of pollution in the Humber. Two sites receiving considerable volumes of industrial and domestic effluents coincide with extreme dominance areas for T. benedeni and very low diversity values. T benedeni conducts its entire life cycle in the relative safety of the subsediment and exhibits a high tolerance for anoxia. These qualities make this tubificid oligochaete a genuine pollution indicator in the more saline reaches of estuaries and coastal habitats. (Geiger-FRC)
W84-00025

CANDIDA ALBICANS AS AN ALTERNATIVE SANITARY INDICATOR ORGANISM FOR WATERS CONTAINING ACID MINE DRAINAGE,
West Virginia Univ., Morgantown. Water Research Inst.
D. A. DePasquale, C. B. Law, and G. K. Bissonnette.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111814, Price codes: A03 in paper copy, A01 in microfiche. Water Research Institute Completion Report, 1983. 32 p, 7 Fig, 7 Tab, 40 Ref. OWRT A-047-WV(1), 14-34-0001-2152.

Descriptors: *Acid mine drainage, *Bioindicators, Indicators, Sanitary wastewater, *Survival, Water quality, *Yeasts, Bacteria, Coliforms, Domestic wastes, Enteric bacteria, Feces, Microorganisms, Mine drainage, Pathogens, Pollutant identification, Sewage bacteria, Streptococcus, Urine, Water pollution, Water pollution effects.

Microbiological studies were conducted to assess the potential of using Candida albicans as a sanitary-indicator organism in streams impacted by acid mine drainage (AMD) and organic wastes. C. albicans was detected at low densities in AMD, particularly when compared to the occurrence of traditional indicator bacteria. The relatively lower density of C. albicans in AMD was a reflection of its likewise low incidence in raw sewage. Pure-culture survival studies indicated that C. albicans is extremely resistant to the adverse effects of AMD as demonstrated by prolonged persistence of at least three days. In addition to its extended survival, C. albicans incurred minimal sublethal injury from AMD stress. Exposure of traditional indicator bacteria to identical conditions resulted in significant sublethal injury. The failure of standard microbiological procedures to detect AMD-damaged bacteria compromises the accuracy of assessing the public health safety of these waters. On the other hand, the marked resistance of C. albicans to injury lends support to its use as an alternative sanitary-indicator organism in streams containing acid mine drainage (AMD).
W84-00041

SODIUM HEXAMETAPHOSPHATE AS AN AID IN BENTHIC SAMPLE SORTING,
Central Electricity Generating Board, Southampton (England). Marine Biological Lab.
R. N. Bamber.
Marine Environmental Research, Vol 7, No 4, p 251-255, 1982. 2 Fig, 2 Tab, 4 Ref.

Descriptors: *Sampling, *Benthic environment, *Sedimentation, Sediments, Sodium hexametaphosphate, Sieving, Muds, Clays, Silts, Benthic fauna, Aquatic animals, Benthos, Fauna, *Pollutant identification, River Medway, England.

Since sieving problems had been experienced with fine estuarine muds occasionally exposed to erratic oil spillage in the River Medway, experimental analysis was undertaken to determine the efficacy of the addition of sodium hexametaphosphate to the initial fixative preservative for benthic samples. The presence of 1.24 g/liter sodium hexametaphosphate in the fixative solution was seen to significantly aid the disaggregation of fine sediment and thereby increase the efficiency of sieving benthic samples by some 23%. Concentrations greater than 1.24 g/liter do not significantly improve upon this performance. Observation of animal specimens from the samples subsequent to sieving demonstrated no inhibition of staining or fixation, and since the function of Rose Bengal staining is not critically dependent upon the precise color, proposed spectrophotometric analysis of the effect of the hexametaphosphate on the color of the stain was unnecessary. Foraminiferan shells were common in the samples and showed no evidence of degradation. The proportion of material passing through the sieve during the limited sieving time of the experiment when compared with the particle size structure of the inorganic sediment suggests that for these sediments at least, no extra treatment such as freezing is needed to further enhance the efficiency of sample sorting. Up to 90% of the treated samples passed the sieve, compared to an inorganic fraction of less than 0.5 mm of 96%. (Baker-FRC)
W84-00140

APPLICABILITY OF CERTAIN COMMON BIOINDICATION METHODS TO EVALUATION OF WATER QUALITY IN THE LITTORAL ZONE OF THE KREMENCHUG RESERVOIR,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
Yu. V. Pligin, and L. A. Zhuravleva.
Hydrobiological Journal, Vol 18, No 2, p 30-34, 1982. 2 Tab, 16 Ref.

Descriptors: *Eutrophication, *Reservoirs, *Bioindicators, Kremenchug reservoir, Water quality, Littoral zone, Benthos, Invertebrates, *USSR.

The eutrophication-induced changes in water quality in the littoral zone of the Kremenchug Reservoir were studied by means of bioindicator methods based on benthic invertebrates and hydrochemical indices. Macrozoobenthos and water were sampled for chemical analysis in five main shallow areas of the reservoir. Analyses were made of 360 quantitative samples of macrozoobenthos, collected in years with very hydrometeorological conditions. Six bioindicator procedures were evaluated, of which the systems of Goodnight and Whitley, King and Ball proved most applicable. The methods of Parele and Pantle and Bucca were less suitable, and those of Balushkina and Woodiwiss failed to work in this context. If macrozoobenthos analysis is to be used for water quality estimation, several procedures that would take into account as many species of invertebrates as possible should be jointly employed. (Baker-FRC)
W84-00146

TRACE ANALYSIS OF SULFAMETHAZINE IN ANIMAL FEED, HUMAN URINE, AND WASTEWATER BY ELECTRON CAPTURE GAS CHROMATOGRAPHY,
National Center for Toxicological Research, Jefferson, AR.
C. L. Holder, H. C. Thompson, Jr., and M. C. Bowman.
Journal of Chromatographic Sciences, Vol 19, No 12, p 625-633, December, 1981. 8 Fig, 5 Tab, 17 Ref.

Descriptors: *Drugs, *Wastewater analysis, Sulfamethazine, Chemical analysis, Chromatography, Gas Chromatography, Trace levels, Pollutant identification, Feeds.

An electron capture gas chromatography method was developed for the determination of sulfamethazine, an antibacterial additive for animal feed, in wastewater at levels of 10 ppb. This toxic substance has the formula 4-amino-N-(4,6-dimethyl-2-pyrimidinyl) benzenesulfonamide. After cleanup by dichloromethane extraction, the samples were evaporated to dryness, methylated with diazomethane, acetylated with trifluoroacetic anhydride at the primary amine function, cleaned up on silica

gel, and assayed with electron capture gas chromatography. The compound was extremely stable in water. After 16 days storage at ambient temperature, solutions of 50 ppm and 500 ppm sulfamethazine yielded recoveries of 50 ppm and 496 ppm, respectively. (Cassar-FRC)
W84-00307

DETERMINATION OF TRACE AMOUNTS OF CHROMIUM (VI) IN PRESENCE OF SULFITE ION IN WASTEWATERS OF SURFACE TREATMENT (DETERMINATION DES TRACES DE CHROME (VI) EN PRESENCE DE SULFITE DANS LES EAUX RESIDUAIRES DE TRAITEMENT DE SURFACE),
Institut National de la Sante et de la Recherche Medicale, Paris (France).
P. Bourbon, J. Alary, J. -C. Lepert, and C. Balsa.
Analusis, Vol 9, No 3, p 110-112, 1981. 2 Fig, 6 Ref.

Descriptors: *Chromium, *Measurement techniques, *Trace levels, Heavy metals, Wastewater analysis.

Trace amounts of chromium (VI) cannot be determined in the presence of sulfite in wastewaters from surface treatment using the common techniques of spectrophotometry with diphenylcarbazide or atomic absorption after extraction with MIBK. A method of determination using pulse polarography is proposed. This method yields satisfactory results even in the presence of several metallic ions. Copper interferes with the method when its concentration exceeds 0.4 milligrams per liter and must be eliminated by precipitation at a pH of 9.5 to 10. The sensitivity of this method (20 micrograms of chromium (VI) per liter) is of the same order of magnitude as that achieved using the spectrophotometric method with diphenylcarbazide. In the absence of copper, the proposed method can also be used to determine the concentrations of some metallic ions, including cobalt, nickel, cadmium, and zinc, in the same sample. (Carroll-FRC)
W84-00308

IS ATP A SUITABLE BIOMASS PARAMETER FOR ACTIVATED SLUDGE. PART 1: THEORETICAL PRINCIPLES AND STATEMENT OF THE PROBLEM (IST ATP EIN GEEIGNETER BIOMASSE-PARAMETER FUR BELEBTE SCHLAMME. 1. MITTEILUNG: THEORETISCHE GRUNDLAGEN UND PROBLEMSTELLUNG),
Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wasserguete- und Abfallwirtschaft.
E. Thomanetz, A. Sperandio, and D. Bardtke.
Gas- und Wasserfach: Wasser/Abwasser, Vol 123, No 2, p 96-101, 1982. 3 Fig, 24 Ref.

Descriptors: *Activated sludge process, *Adenosine triphosphate, *Metabolism, Activated sludge, Bacteria, Biomass, Microbiology, Bacterial analysis.

Methods of activated sludge biomass analysis are discussed. Since live bacteria cannot be quantified, the number of live cells, or the DNA content correlatable with it, would appear to be a suitable biomass parameter for viable numbers in activated sludges. However, a clear distinction must be made between viable numbers in sludges and the metabolic activity of such sludges. The essential biochemical properties and the possible reactions of ATP (adenosine triphosphate) are described. It is shown that, while ATP is clearly not suitable as a parameter for viable numbers of bacteria in activated sludges, it may conceivably be suitable--though possibly with certain reservations--as a parameter for the metabolic activity of these sludges. (Carroll-FRC)
W84-00323

DETERMINATION OF TRACES OF SODIUM ALKYLBENZENESULPHONATE BY HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY. APPLICATION TO WATER,
Government Industrial Research Inst., Osaka (Japan).
T. Saito, K. Higashi, and K. Hagiwara.
Fresenius Zeitschrift Analytische Chemie, Vol 313, No 1, p 21-23, 1982. 3 Fig, 2 Tab, 5 Ref.

Descriptors: *Pollutant identification, *Chromatography, *Water analysis, *Alkylbenzenesulfonate, Ion exchange, Surfactants, High pressure liquid chromatography, Detergents.

High-performance liquid chromatography has been developed for the analysis of traces of alkylbenzenesulfonate in water. The method consists in the first stage of ion-exchange separation of dodecylbenzenesulfonate in water, and in the second stage, their determination by HPLC. The following conditions were employed: Shimadzu ZORBAX SIL Column (5 micrometers, 4.6 mm i.d. x 150 mm) as stationary phase, 0.2% ammonia-ethanol (v/v) as mobile phase, UV detector at 225 mm, injection volume 12 microliters. The chromatograms of alkylbenzenesulfonate (ABS) were simple and sharp, with a detection limit of 0.02 micrograms in 12 microliters of ethanol. Calibration curves of ABS were linear in a concentration range of 0.03 to 0.3 micrograms in 12 microliters of ethanol. In the case of linear sodium dodecylbenzenesulfonate positive errors of 1-4% were caused by nonionic surfactants or lauryl sulfate (6 fold excess); 10-50% positive errors were caused by 2-6 fold excess of household detergents. Standard water samples containing ABS were treated with a weak base anion-exchange resin; the adsorbed ABS were eluted and then determined either by HPLC or by the methylene blue spectrophotometric method. Recoveries of ABS in water were about 92-107% by HPLC. (Baker-FRC)
W84-00329

SIMULTANEOUS DETERMINATION OF HEAVY METALS IN WATERS BY INDUCTIVELY-COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY AFTER EXTRACTION INTO DIISOBUTYL KETONE,
National Research Inst. for Pollution and Resources, Ibarkai (Japan).
A. Miyazaki, A. Kimura, K. Bansho, and Y. Umezaki.
Analytical Chimica Acta, Vol 144, p 213-221, 1982. 2 Fig, 4 Tab, 22 Ref.

Descriptors: *Pollutant identification, *Heavy metals, *Spectrophotometry, *Separation techniques, *Seawater, Chelating agents, Metal complexes, Cadmium, Lead, Zinc, Nickel, Copper, Iron, Molybdenum, Vanadium, Rivers, Water analysis, Metals.

The simultaneous determination of cadmium, lead, zinc, iron, copper, nickel, molybdenum and vanadium in river and sea water by inductively-coupled plasma atomic emission spectrometry was investigated. Diisobutyl ketone (DIBK) was used as solvent due to its low aqueous solubility and ease of introduction into the inductively-coupled plasma. The optimum observation height for the DIBK extract proved higher than that for an aqueous solution. Ammonium pyrrolidinedithiocarbamate (APDC) was used as chelating reagent at pH 2.4. The metals could be determined in samples at the microgram/liter level with detection limits ranging from 0.022 for cadmium to 0.60 for lead. The procedure should be applicable to other elements which form complexes with APDC. (Geiger-FRC)
W84-00334

TRACE METAL DETERMINATIONS IN ESTUARINE WATERS BY ELECTROTHERMAL ATOMIC ABSORPTION SPECTROMETRY AFTER EXTRACTION OF DITHIOCARBAMATE COMPLEXES INTO FREON,
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Analytical and Marine Chemistry.
L. G. Danielsson, B. Magnusson, S. Westerlund, and K. Zhang.
Analytica Chimica Acta, Vol 144, p 183-188, 1982. 3 Tab, 7 Ref.

Descriptors: *Heavy metals, *Pollutant identification, *Atomic absorption spectrophotometry, Salinity, Estuaries, Lead, Cadmium, Iron, Nickel, Zinc, Copper, Separation techniques.

The determination of cadmium, copper, iron, lead, nickel and zinc in estuarine waters by electrothermal atomic absorption spectrometry after extraction of dithiocarbamate complexes into freon is described. Samples of water are treated with 65% nitric acid and the dithiocarbamate complexes are extracted into Freon-TF and then back-extracted into dilute nitric acid solution. Portions of the back extracts are injected into a graphite furnace. A solution of mixed acetate buffer-complexing agent is used to eliminate the effect of high iron concentrations on the extraction procedure. The present method allows complete separation from the matrix irrespective of salinity and can be used throughout the full salinity range of an estuary. (Geiger-FRC)
W84-00347

5B. Sources Of Pollution

GROUNDWATER MONITORING AT A SEPTAGE LAGOON FACILITY,
Connecticut Univ., Storrs. Dept. of Agricultural Engineering.
J. Kolega, B. Morton, and H. Luce.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110758, Price codes: A02, in paper copy, A01 in microfiche. Institute of Water Resources Completion Report, September 1983. 14 p, 2 Fig, 3 Tab, 13 Ref. OWRT A-090-CONN(1), 14-34-0001-2107.

Descriptors: *Groundwater pollution, *Lagoons, Leachates, Septic sludge, Septic wastewater, Connecticut, Monitoring, Path of pollutants, Waste disposal.

A groundwater monitorng network was installed at a newly constructed earthen septage (septic tank pumpings) treatment and disposal facility at Coventry, CT to study the movement of chloride, nitrogen, trace metals, and hydrocarbons from the septage lagoons and their effect on groundwater quality. The facility was situated in a glacial outwash deltaic kame located adjacent to a floodplain wetland abutting the Willimantic River. The soil at the site was a glacial-fluvial deposit of sand typical of many river valley sections in southern New England. Groundwater elevations at the monitoring wells were measured prior to water sample collection along with the redox potential, salinity and the specific conductance. Sealing from the biomat formation at the septage-soil interface of the primary lagoon bottom did not occur nor did complete nitrification take place. Of the trace metals, cadmium, chromium, and lead were observed beneath the primary lagoon at concentrations which were above the adverse effect level for drinking water in the United States. Certain organohalides exceeded the recommended limits to protect human health.
W84-00002

STUDY OF MICROBIAL INACTIVATION IN THE MARINE ENVIRONMENT,
Malaga Univ. (Spain). Dept. of Microbiology.
J. J. Borrego, F. Arrabal, A. de Vicente, L. F. Gomez, and P. Romero.
Journal of the Water Pollution Control Federation, Vol 55, No 3, p 297-302, March, 1983. 2 Fig, 5 Tab, 19 Ref.

Descriptors: *Marine environment, *Bacteria, *Outfalls, *Wastewater disposal, Water pollution sources, Salmonella, Seawater, Escherichia coli, Pollution indicators, Monitoring, Spain, Aladino outfall, Bioindicators.

Microbial inactivation in the marine environment occurs by two different processes - physical dilution by diffusion, or a process of biological inactivation. Microbial inactivation was studied at the Aladino outfall, located off Carihuela beach, Spain, which discharges about 1,000 m from the coast. It consists of an 800 ml drainage pipe without terminal diffusors. The depth of discharge is about 19 m, and it is classified as a deep outfall because its

discharge forms a mixing layer of less than the total depth of the seawater. It has an irregular flow, depending on the time of day, with a maximum at 3 pm of 15 liters/second. The minimum is in the early morning. Data collected at the outfall show that most bacterial species underwent an initial dilution of over 90%. Salmonella-Shigella loses its viability most rapidly, perhaps because of poor adaptive capacity. However, the overall degrees of inactivation achieved, in descending order, are total coliform, fecal coliform, Salmonella-Shigella, coliphage, and fecal streptococci. Using Escherichia coli-specific bacteriophage as a pollution indicator is an attractive consideration, but more study is needed. (Baker-FRC)
W84-00016

DEGRADATION OF ATRAZINE IN ESTUARINE WATER/SEDIMENT SYSTEMS AND SOILS,
Salisbury State Coll., MD.
T. W. Jones, W. M. Kemp, J. C. Stevenson, and J. C. Means.
Journal of Environmental Quality, Vol 11, No 4, p 632-638, October-December, 1982. 5 Fig, 3 Tab, 28 Ref.

Descriptors: *Herbicides, *Sediment, *Degradation, *Fate of Pollutants, *Atrazine, Pesticides, Estuaries, Agricultural soils, Soils, Chesapeake Bay, *Maryland.

The fate of atrazine (2-chloro-4-ethylamino-6-isopropyl-amino-s-triazine) was studied in two estuarine water/sediment microsoms, using water from a protected Chesapeake Bay site and from an open bay site, and in two agricultural soil systems (sandy loam and silty loam). Experiments were done under both aerobic and anaerobic conditions. Half-lives for atrazine were: water, 3-12 days (faster in open water samples than in protected site samples); sediments, 15 and 20 days; and soils, 330 and 285 days. These half-lives were based on the assumption that the ratio of atrazine and metabolites in the nonextractable portion was the same as in the extractable portion. Low oxygen conditions had littleeffect on the rate of atrazine degradation. The major short-term metabolite of estuarine and soil systems was hdroxyatrazine (2-hydroxy-4-ethylamino-6-isopropylamine-s-triazine). (Cassar-FRC)
W84-00018

FOOD CHAIN ENRICHMENT OF ORGANOCHLORINE COMPOUNDS AND MERCURY IN CLEAN AND POLLUTED LAKES OF FINLAND,
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
J. Paasivirta, J. Sarkka, K. Surma-Aho, T. Humppi, and T. Kuokkanen.
Chemosphere, Vol 12, No 2, p 239-252, 1983. 3 Fig, 9 Tab, 14 Ref.

Descriptors: *Food chains, Enrichment, *Lakes, *Finland, Fish, *Mercury, *Organochlorines, Pulp and paper industry, *Pulp wastes, Chlorinated hydrocarbons, Phenols.

A new sampling and analysis program was constructed for determining contents of mercury and chlorinated hydrocarbons and chlorinated phenols in different trophic levels of lakes in central Finland. The lakes under study are polluted by pulp mill and urban wastes. They contain pulp chlorine bleaching residues, mercury, methyl mercury, and organochlorine compounds in sediment, plankton, roach and pike. A 30-fold increase in mercury in bottom sediments has resulted from chlorine bleaching agents dumped in the lakes. This was not reflected in mercury levels in fish, which were highest at one natural condition (humic) lake and rather high also in semipolluted lake Paijanne. Mercury in fish was mostly methylated, but not completely, and its time trends could be estimated. Chloroform showed no bio-accumulation in fish. Carbon tetrachloride, tetrachloroethylene and chlorinated cymenes significantly bioaccumulated in fish. Levels of chlorophenols from bleaching had strongly decreased, but pentachlorophenol and 2,3,4,6-tetrachlorophenol levels remained related to earlier results. The present results show that although sediment seems to serve for storage of certain persistent biocides, the contents in bottom sediments do not directly reflect the contents in biota. (Baker-FRC)
W84-00023

THE EVALUATION OF METALS AND OTHER SUBSTANCES RELEASED INTO COAL MINE ACCRUAL WATERS ON THE WASATCH PLATEAU COAL FIELD, UTAH,
Utah Water Research Lab., Logan.
A. J. Seierstad, V. D. Adams, V. A. Lamarra, N. J. Hoefs, and R. E. Hinchee.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111681, Price codes: A08 in paper copy, A01 in microfiche. Water Quality Series UWRL/Q-83/09, August 1983. 156 p, 30 Fig, 46 Tab, 68 Ref, 1 Append. OWRT B-210-UTAH(2), 14-34-0001-1273.

Descriptors: Coal, Coal mining, *Coal mines, *Leachates, Boron, Strontium, Water pollution control, Iron, *Acid mine drainage, Alkalinity, Mercury, Suspended solids, Grease, Hardness, Filtered wastewater, *Utah, Wasatch Plateau, *Metals.

In the face of probable coal mining expansion on the Wasatch Plateau of Central Utah, threats to drinking water safety and healthy aquatic environments were examined by reviewing reports submitted by mine operators as required by the National Pollution Discharge Elimination System, measuring pollutant concentrations in mine accrual waters before and after treatment, and analyzing experimental leachates obtained by upward flow of waters (prepared to match average natural conditions) through crushed coal in laboratory columns. The reports, mine accrual waters, and leachates covered six mines, four of which continually discharged water, and two of which were collecting water internally. One sump is being used for drinking water supply. Sampling continued from April 1981 through May 1982. Constituents measured and compared with water quality criteria for drinking, irrigating, stock watering, and aquatic resources included pH, suspended solids, metals, hardness, alkalinity, and silica. Generally, the waters did not exceed toxicity criteria, and concentrations leached from crushed coal samples provided a reasonable guide to concentrations measured in the accrual waters. Boron concentrations were occasionally high enough to affect sensitive crops. Mercury seldom exceeded standards but was generally close enough to deserve special monitoring and analysis for possible environmental effects. Acidity and iron were not a problem, but total suspended solids as well as oil and grease often were. The existing treatment by gravel filtration ponds and grease skimming devices was not very effective. Overall, the results did not find a significant pollution problem, identified potential hazards, and provided more cost effective pollution control information.
W84-00028

EVALUATION OF THE POTENTIAL FOR GROUNDWATER TRANSPORT OF MUTAGENIC COMPOUNDS RELEASED BY SPENT OIL SHALE,
Utah Water Research Lab., Logan.
R. E. Hinchee, V. D. Adams, J. G. Curtis, and A. J. Seierstad.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111699, Price codes: A07 in paper copy, A01 in microfiche. Water Quality Series UWRL/Q-83/06, July 1983. 127 p, 23 Fig, 22 Tab, 150 Ref, 2 Append. OWRT B-210-UTAH(1), 14-34-0001-1273.

Descriptors: *Carcinogens, *Bioassay, Coal, *Oil shale, *Leachates, Water pollution sources, Groundwater pollution, Organic carbon, *Mutagenic compounds, *Utah, Wasatch Plateau, Anvil Points, *Retort processes.

The potential mutagenicity of aqueous leachates from coal, raw oil shale, and the spent shale resulting from two processes was tested. Specifically, an Ames salmonella microsomal bioassay was used to test for chemical mutagenicity. Spent oil shales from the Paraho and TOSCO II processes, a raw shale from Anvil Points, and a composite coal sample from Wasatch plateau were extracted with double deionized water and organic solvents. Of the tests, only organic solvent extraction of the TOSCO spent shale resulted in a mutagenic response. The lack of mutagenic response to organic extracts of Paraho spent shale was unexpected and probably due to high temperatures at which the shale had been retorted. By using a TOSCO spent shale leachate and an organically extracted mutagen, a partition relationship was developed between the spent shale and leachate water. A discovered high affinity of the mutagen for spent shale was believed to minimize amounts getting into the leachate. Consequently, it was estimated that the mutagenicity of spent shale leachate will be low (in the range of that of chlorinated wastewater). However, the large volumes of water required to complete the leaching of the mutagens from the pile are likely to create a chronic long-term problem.
W84-00029

EFFECTS OF CADMIUM ON STREAMS AND IRRIGATED AGRICULTURE IN THE PRESENCE AND ABSENCE OF OIL SHALE LEACHATE,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5C.
W84-00030

HERBICIDES IN RUNOFF FROM AGRICULTURAL WATERSHEDS IN A HIGH-WINTER-RAINFALL ZONE,
Oregon State Univ., Corvallis. Dept. of Soil Science.
J. S. Hickman, M. E. Harward, and M. L. Montgomery.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111772, Price codes: A06 in paper copy, A01 in microfiche. Water Resources Research Institute Publication WRRI-86, Oregon State Univ., Corvallis, September 1983. 107 p, 19 Fig, 8 Tab, 95 Ref, 1 Append. OWRT B-075-ORE(1), 14-34-0001-0276.

Descriptors: *Herbicides, *Agricultural runoff, *Diclofop-methyl, *Diclofop, Hydrolysis, Chemical degradation, Leaching, *Trifluralin, Subsurface drainage, Stream pollution, Soil properties, *Agricultural watersheds, Path of pollutants, *Oregon, Williamette Valley.

Runoff losses were quantified for two herbicides from fall-planted agricultural watersheds in the Williamette Valley, Oregon. Factors and processes influencing herbicide transport were indentified. Diclofop runoff losses were measured following a January application (1.12 kg/ha) of diclofop-methyl. Diclofop-methyl rapidly hydrolyzed to diclofop ($t1/2 < 1$ day), while degradation beyond the diclofop molecule was much slower ($t1/2 = 42$ days). Runoff losses were 7.1 and 3.9% of the applied herbicide in 1980 and 0.7 and <0.1% in 1981 at a 6.0 ha and 1.4 ha (subsurface drained) watershed, respectively. The maximum diclofop concentrations were 370 and 790 mg/m super 3 at the two watersheds, respectively. More than 80% of the diclofop loss was partitioned into the aqueous phase of runoff. Runoff losses of trifluralin following a 0.84 kg/ha October 1979 application were 0.9 and <0.1% and maximum concentrations were 216 and 9.5 mg/m super 3 at the 6.0 and 1.4 ha watersheds, respectively. Lowere runoff losses of both herbicides at the 1.4 watershed were attributed to the effectiveness of the subsurface drainage system (a potential management practice) in reducing antecedent soil moisture. Herbicide losses in the subsurface drainage effluent accounted for 1.2 and <0.1% of the applied diclofop in 1980 and 1981, respectively, and <0.1% of the applied trifluralin. Major factors affecting herbicide runoff losses were (1) proximity of the first runoff event to the application date, (2) soil moisture status before and during storm events, (3) magnitude of the precipitation events, and (4) formation of a soil crust.
W84-00037

NATURE OF PHOSPHORUS FRACTIONS IN LAND RUNOFF AND THEIR AVAILABILITY TO ALGAE,

Cornell Univ., Ithaca, NY.
J. P. Barlow, D. R. Bouldin, R. T. Oglesby, W. R. Schaffner, and M. S. Glase.

Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111830, Price codes: A04 in paper copy, A01 in microfiche. Center for Environmental Research Completion Report, (1983). 63 p, 15 Fig, 11 Tab, 15 Ref. OWRT B-098-NY(1), 14-34-0001-1251.

Descriptors: *Phosphorus, *Biological availability, *Algal assay, Reactive phosphorus, Organic phosphorus, Sorption, Particulate phosphorus, Soil nutrient losses, *Agricultural runoff, New York.

Phosphorus in agricultural discharge and streams was examined for biological availability of soluble fractions and for the quantity of these in discharge. In streams, very little soluble P was detected, even during heavy flow. Although there was considerable variability in the concentration of P discharged from fields, the total amount lost was closely related to the amount of water discharged. Soluble P, both molybdate reactive and unreactive was largely biologically available as determined by algal bioassays and bioassays using natural pond microfloral assemblages. Soluble P which was less available after herbicide treatment or frosts may have resulted from breakdown of plant material. Sorption reactions during mixing of field discharge with stream water were estimated by adding increasing amounts of low P water to discharge water. Generally, soluble molybdate reactive P was absorbed and decreased in concentration while soluble unreactive P was desorbed and increased in concentration. Sorption was related to the quantity of suspended particulates.
W84-00043

TRACE METALS IN SEDIMENTS OF THE ST. JONES AND MURDERKILL RIVERS, DELAWARE,

Delaware Univ., Newark. Coll. of Marine Studies.
D. Hoffman, and R. Biggs.

Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111897, Price codes: A02 in paper copy, A01 in microfiche. Water Resources Center Completion Report, September 1983. 14 p, 2 Fig, 4 Tab, 2 Ref. OWRT A-055-DEL(1), 14-34-0001-2108.

Descriptors: *Trace metals, *Sediments, *Estuaries, *Delaware, Water chemistry, St. Jones River, Murderkill River, Copper, Cadmium, Zinc, Chromium, Iron, Lead, Manganese, Pollutant identification, Water pollution sources.

The metals Cu, Cd, Cr, Zn, Fe, Mn, Pb were analyzed from surface sediments from 47 locations in the Murderkill and St. Jones Rivers, Delaware. Prior to 1976, the St. Jones received domestic sewage from the City of Dover, Delaware. A regional sewage plant began operations in 1976 and discharged the combined wastes from Dover and surrounding areas into the Murderkill. Results of the 1982 metals survey were compared with data obtained by the same authors at the same locations in 1973. Cu, Cd, and Pb show higher concentrations in Murderkill bed sediments in 1982 than in 1973. These concentrations decrease in the mainstem river away from the STP discharge points. Cr, Fe, and Mg do not show such excursions and are indistinguishable from the 1973 concentrations. Metal concentrations in bed sediments of the St. Jones River show no change for 1973 to 1980, except that Pb, Cd and Zn sediment concentrations are generally lower in 1982. The analyses suggest that Cu, Cd, and Pb are increasing in the sediments from the Murderkill while Fe, Mn, and Cr are not. Pb, Cd, and Zn are decreasing in the St. Jones sediments, perhaps because they are being leached from the sediments or because they are being buried and diluted with clean materials.
W84-00049

METAL LOADING OF THE B. EVERETT JORDAN RESERVOIR,

North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
M. S. Shuman, K. G. Robinson, and C. E. Stokes.

Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111913, Price codes: A04 in paper copy, A01 in microfiche. Report No 200, July 1983. 60 p, 7 Fig, 14 Tab, 30 Ref. OWRT A-112-NC(1), 14-34-0001-1135.

Descriptors: Metals, *Heavy metals, Zinc, Cadmium, Lead, Copper, Mercury, Streams, Rivers, *Reservoirs, Streamflow, Low flow, High flow, Suspended sediments, Particulate matter, Dissolved solids, Particle size, Municipal wastewater, Urban runoff, *North Carolina, B. Everett Jordan Reservoir.

Filterable and non-filterable Zn, Cd, Pb, Cu and Hg concentrations were examined in streams which form the B. Everett Jordan Reservoir, N.C. Stream samples were collected to coincide with low and high flow events. Zinc, Cu, Pb and Hg were transported principally in the non-filterable fraction and at high flow, whereas less than 20% of the Cd was transported in that fraction. Metal loadings were estimated from flow-weighted mean metal concentrations and mean stream flow data and indicated the importance of sampling during high flow events. Metal concentrations at high flow depended less on flow magnitude than the time relative to peak flow when the sample was collected. The order of metal loading was Zn>Cu>Pb>Hg with the industrialized Haw River sub-basin contributing more metals Zn (19.7 X 10 super 3 g/km super 2-yr), Cd (32.4 X 10 super 1 g/km super 2-yr), Pb (5.0 X 10 super 3 g/km super 2-yr), Cu (8.8 X 10 super 3 g/km super 2-yr), and Hg (4.2 X 10 super 1 g/km super 2-yr)), Pb (1.4 X 10 super 3 g/km super 2-yr) Cu (2.1 X 10 super 3 g/km super 2-yr) and Hg 2.5 g/km super 2-yr).
W84-00051

TRANSPORT OF POLLUTANTS IN NATURAL STREAMS,

Windsor Univ. (Ontario). Dept. of Civil Engineering.
J. A. McCorquodale, E. H. Imam, J. K. Bewtra, Y. S. Hamdy, and J. K. Kinkead.

Canadian Journal of Civil Engineering, Vol 10, No 1, p 9-17, 1983. 4 Fig, 12 Ref.

Descriptors: *Organic compounds, *Industrial wastes, *Outfalls, Fate of pollutants, Model studies, Mathematical models, Mixing, St. Clair River, *Ontario, Rivers, Dispersion, *Path of pollutants.

Dispersion of soluble degradable and nondegradable pollutants discharged from multiple industrial sources into a large river was simulated by a two-dimensional mathematical model. The Akhtar (1978) model was modified to include the effect of depth and velocity variations in both longitudinal and lateral directions, the effect of rapid convergence or divergence of stream width, lateral convection of mass, the effect of flow diversion, the effect of jet mixing and dilution at shore-based and extended outfalls, and the removal rates of degradable trace organic pollutants. The model is divided into two parts: the river hydrodynamics model and the pollutant transport model. The model was validated by using phenol as a pollutant and comparing model results with observed data obtained from the St. Clair River, Ontario. A simulation using effluent discharges from 24 sources at 19 different locations produced results for phenol, benzene, toluene, methylene chloride, and carbon tetrachloride the agreed well with measured concentrations of the chemicals in river water. It was observed that pollutants disperse slowly when discharged in a shallow, slow-moving zone of the river and disperse rapidly once they reach the deeper water. The deeper the outfall, the faster the lateral dispersion of pollutants into the river. (Cassar-FRC).
W84-00072

DESIGN OF SEA OUTFALLS - THE LOWER LIMIT CONCEPT OF INITIAL DILUTION,

For primary bibliographic entry see Field 5E.
W84-00076

WASTE-RELATED CADMIUM CYCLE IN SWITZERLAND,

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
L. Keller, and P. H. Brunner.

Ecotoxicology and Environmental Safety, Vol 7, No 1, p 141-150, 1983. 6 Fig, 6 Tab, 14 Ref.

Descriptors: *Cadmium, *Fate of pollutants, *Land disposal, *Spatial distribution, *Bioaccumulation, *Composting, *Sludge disposal, Heavy metals, Landfills, Soil amendments, Leaching, *Switzerland.

In Switzerland, an average of 120 tons of cadmium are used each year. Of this amount, an estimated 25 tons end up in municipal solid waste, 3 tons in wastewater, and 19 tons in precipitation and dry fallout. About 40 tons of cadmium annually are deposited directly to the soil via landfills, the atmosphere or the fertilization of agricultural land. Theoretically, the cadmium content of the soil may double in 150 years, thus increasing the cadmium content of plants grown on such soil. Model studies predict that soil cadmium levels should not exceed 3 ppm. At such levels, plants are likely to attain cadmium levels > 0.4 milligrams/kilogram, a concentration which can cause toxic effects in long term experiments. Since cadmium is not distributed evenly over Switzerland, the use of compost may render many soils unfit for the production of crops intended for human consumption in only 14 years. For sewage sludge application to cropland, this time span is 130 years. In a steady state, the cadmium input to soil should equal its output via plants, leachate, and erosion. The dissipative use of cadmium must be stopped if heavy metal limits in food are to be observed. (Geiger-FRC)
W84-00078

IMPACT OF DROUGHT ON QUALITY OF POTENTIAL WATER SUPPLY SOURCES IN THE SANGAMON RIVER BASIN,

Southern Illinois Univ. at Carbondale. Dept. of Thermal and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W84-00105

POLLUTANT-PARTICLE ASSOCIATIONS AND DYNAMICS IN COASTAL MARINE ENVIRONMENTS: A REVIEW,

Oak Ridge National Lab., TN. Environmental Sciences Div.
C. R. Olsen, N. H. Cutshall, and I. L. Larsen.

Marine Chemistry, Vol 11, No 6, p 501-533, 1982. 8 Fig, 182 Ref.

Descriptors: *Estuarine environment, *Water pollution sources, *Sedimentation, Dynamics, Coastal waters, *Reviews, Chemical reactions, Sediment transport, Fate of pollutants.

This review indicates that many pollutants rapidly become associated with particles in coastal marine environments and that these particles are then effectively trapped in the estuaries. This association may result from ionic sorption and flocculation, organic complexation and flocculation, hydrophobic interactions with particle surfaces, bio-aggregation, or sorption and co-precipitation with Mn-Fe hydroxides. The net transport of particles and associated pollutants is downstream in the lower salinity surface layer of an estuary, but as these particles settle to the more saline bottom they may be transported back upstream and trapped by estuarine circulation. The rate of particle-pollutant deposition is generally high and is governed to a great extent by estuarine sedimentary processes. Several processes such as sediment resuspension, diffusion from anoxic sediments, and dredging-dumping operations can reintroduce pollutants to marine waters which had already settled out. Dissolved nutrients that may escape an estuary stimulate productivity in near-shore coastal waters and are rapidly removed by biological processes, frequently forming plankton plumes at estuary mouths. Major removal mechanisms for pollutants in shelf waters include sorption onto resuspended sediments, incorporation into living organisms and sinking of

organic debris or boundary-layer scavenging in association with the redox cycling of Mn-Fe hydroxides. Of prime importance in any predictive model is a quantitative understanding of the rates associated with the biogeochemical processes that affect pollutant-particle dynamics. These process-oriented transfer rates include: input rates into the marine environment, exchange rates across the air-sea interface, transport rates in the water column, and transfer into and out of the sediments. Quantitative values for the above transfer rates are needed to determine particle-pollutant fluxes and define how long a pollutant will persist. (Baker-FRC)
W84-00141

A METHOD FOR CALCULATING THE RATE OF BIOSEDIMENTATION THROUGH THE LOWER BOUNDARY OF THE PHOTOSYNTHETIC ZONE IN SEA WATER,
Institute of Biology of the Southern Seas, Sevastopol (USSR).
For primary bibliographic entry see Field 1B.
W84-00143

MICROBIOLOGICAL CONDITIONS AND WATER QUALITY IN THE LOWER DNIEPR,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
E. Ya. Rossova, T. G. Moroz, R. A. Kokoreva, G. N. Shakhman, and T. L. Aleksenko.
Hydrobiological Journal, Vol 18, No 2, p 52-57, 1982. 5 Fig, 1 Tab, 12 Ref.

Descriptors: Water quality, *Bioindicators, Lakes, Dniepr River, Rivers, *Water quality control, Indicators, Microbiological studies, Bacteria, Seasonal variation, Bacterioplankton, *USSR.

The microbiology of the lower Dniepr was investigated and its water quality evaluated based on microbiological, hydrobiological and hydrochemical properties. The decomposition of organic matter and the self-purification of water occurred at the highest rates in the branches of the Dniepr within the city of Kherson in spring and summer. The degree of pollution and water quality of various sections of the lower Dniepr varied by seasons. Above and below Kherson, the Dniepr in all seasons except summer is pure or only slightly polluted (oligo-saprobic water). In summer the water is of lower quality (oligo-beta-mesoprobic). In general, the lower Dniepr is pure or only moderately polluted, but its branches within the city are moderately or strongly polluted (beta-alpha-mesosaprobic). (Baker-FRC)
W84-00148

PETROLEUM HYDROCARBONS IN SEDIMENTS OF SOUTHAMPTON WATER ESTUARY,
Bermuda Biological Station for Research, St. George's West.
A. H. Knap, P. J. Leb, P. J. L. Williams, and E. Lysiak.
Marine Environmental Research, Vol 7, No 4, p 235-249, 1982. 4 Fig, 6 Tab, 29 Ref.

Descriptors: *Industrial wastes, *Sedimentation, *Estuaries, Southampton, Refineries, Petroleum industry, Petroleum hydrocarbons, Water pollution sources, Fate of pollutants, *England.

Components of the total carbon cycle in Southampton Water have been investigated. Southampton Water estuary is a typical coastal plain estuary formed from the drowned lower portions of the Test and Itchen Rivers. About 75% of the total industrial discharge to the estuary is from a refinery. The non-volatile input ranges from 1 to 2 tons per day. Data indicate that the industrial outfalls on the southwestern bank of the estuary may be regarded as a substantial point source. Surface sediment hydrocarbon concentrations in the vicinity of the refinery were in the region of 1-3 mg C/g dry weight, falling to 0.5 mg C/g or less at a distance from the refinery. In the vicinity of the refinery Pb-210 dating of a core suggested a very high sedimentation rate, with a petroleum hydrocarbon horizon deeper than 3.5 m in at least one case. In another core, elevated hydrocarbon concentrations at 50-70 cm depth coincided well with elevated copper concentrations at those depths. The hydrocarbon concentrations in surface sediments distant from the refinery were not considered high in relation to other industrialized estuaries, thus demonstrating the importance of sediment adsorption as a mechanism of deposition of petroleum hydrocarbons close to the source. (Baker-FRC)
W84-00150

THE KINETICS OF THE OXIDATION OF FERROUS IRON IN SYNTHETIC AND NATURAL WATERS,
Freshwater Biological Association, Windermere (England).
W. Davison, and G. Seed.
Geochimica et Cosmochimica Acta, Vol 47, No 1, p 67-79, 1983. 5 Fig, 4 Tab, 50 Ref.

Descriptors: *Kinetics, *Iron, *Oxidation, Surface waters, Seasonal variations, Acidity, Particulates, Chemical reactions, Lakes, *Fate of pollutants, Laboratory studies, Anoxic conditions, *England, Esthwaite Lake.

The rate of oxidation of ferrous iron in natural waters was measured in the laboratory under conditions which were as close as possible to natural. Verification of the rate law by investigating the effect of pH, partial pressure of oxygen, and the influence of natural solid phases and changing microbial populations was attempted while maintaining natural conditions. Anoxic water samples were collected from the hypolimnion of a seasonally anoxic lake, Esthwaite Water in the English Lake District, on different days during the summer period of anoxia. The data were consistent with the simple rate law for homogeneous chemical kinetics previously established for synthetic solutions. The rate constant for the oxidation reaction in lake water was indistinguishable from that measured in synthetic samples. It did not appear to be influenced by changes in the microbial populations or by changes in any particulate or soluble components in the water, including iron and manganese. Analysis of the errors inherent in kinetic measurements showed that the estimation of pH was the major error source and that values of the rate constant determined by different workers could easily differ by a factor of six. A universal rate constant is suggested for natural freshwaters in the pH range 6.5 to 7.4. Discrepancies in the effects of ionic strength and interfering substances reported in the literature are highlighted. Generally substances have only been found to interfere at concentrations which far exceed those in most natural waters. (Baker-FRC)
W84-00154

SOURCES, SINKS, AND DISTRIBUTION OF ORGANIC CARBON IN THE ST. LAWRENCE ESTUARY, CANADA,
Bedford Inst. of Oceanography, Dartmouth (Nov Scotia). Atlantic Oceanographic Lab.
F. C. Tan, and P. M. Strain.
Geochimica et Cosmochimica Acta, Vol 47, No 1, p 125-132, 1983. 2 Fig, 5 Tab, 19 Ref.

Descriptors: *Sinks, *Estuaries, *Organic compounds, Carbon, Water pollution sources, Plankton, Sedimentation, Rivers, Gulf of St. Lawrence, Canada, St. Lawrence Estuary, Path of pollutants.

The sources and sinks of the organic carbon in the St. Lawrence Estuary and Gulf of St. Lawrence in Canada were investigated by carbon isotope ratio analysis of particulate, planktonic, and sedimentary organic carbon and dissolved inorganic carbon. In the upper St. Lawrence Estuary particulate organic carbon (POC) isotope ratios are uniform and indistinguishable from those of POC in the St. Lawrence River and of planktonic organic carbon in both areas. The abundance of freshwater diatoms in the upper Estuary suggests that upper Estuary POC is mainly fresh organic matter of riverborne origin. Upper estuary POC is isotopically different from POC in the lower St. Lawrence estuary and Gaspe regions, but is not different from POC from the surface waters of the open Gulf of St. Lawrence. The isotopic composition of planktonic organic carbon mirrors that of the POC, indicating that the POC in the lower estuary is also fresh organic matter. Since the lower estuary POC forms an isotopic barrier between the upper estuary POC and the Gulf of St. Lawrence POC, there appears to be little mixing of POC between these three reservoirs. Therefore POC in the lower estuary and gulf is most likely both produced and deposited in situ. The isotope ratio differences between the planktonic and dissolved inorganic carbon reservoirs shows that the difference varies significantly and somewhat unpredictably between sectors of the area studied. Thus one must use caution in assuming a constant fractionation factor and in applying such a factor to the interpretation of carbon isotope data. (Baker-FRC)
W84-00155

LEVELS OF HEAVY METAL POLLUTANTS IN TWO SPECIES OF MARINE NEMATODES,
Newcastle upon Tyne Univ. (England). Dept. of Zoology.
R. Howell.
Marine Pollution Bulletin, Vol 13, No 11, p 396-398, 1982. 1 Fig, 3 Tab, 19 Ref.

Descriptors: *Nematodes, *Metals, Fate of pollutants, Invertebrates, Heavy metals, Copper, Zinc, Lead, Cadmium, Mercury, Budle Bay, Blythe Estuary, Tees Estuary, *United Kingdom, Enoplus, Benthic fauna, Estuaries.

Heavy metals were determined in two nematode species collected from three sites on Britain's northeast coast: Budle Bay (nonpolluted), Blythe Estuary (significantly polluted), and Tees Estuary (extensively polluted). Mean metal concentrations (ppm) in Enoplus brevis at the 3 sites were: Cu, 61-245; Zn, 147-649; Pb, 20-42; Cd, 8-11; and Hg, 0.15-0.96. Mean metal concentrations (ppm) in Enoplus communis were: Cu, 33-60; Zn, 105-1865; Pb, 14-37; Cd, 5-51; and Hg, 0.11-1.22. Metals levels were lowest in Budle Bay and highest in Tees Estuary, except for Pb and Hg in E. brevis and Zn and Cd in E. communis. (Cassar-FRC)
W84-00158

AN ASSESSMENT OF MARINE POLLUTION IN PUGET SOUND,
National Oceanic and Atmospheric Administration, Seattle, WA. Office of Marine Pollution Assessment.
E. R. Long.
Marine Pollution Bulletin, Vol 13, No 11, p 380-383, 1982. 1 Fig.

Descriptors: *Organic compounds, *Metals, *Marine animals, Fate of pollutants, Puget Sound, Washington, Aromatic hydrocarbons, Water pollution effects, Fish, Pesticides, Chlorinated hydrocarbons, Marine Ecosystems Analysis Report, *Washington.

Selected results of the Marine Ecosystems Analysis Puget Sound project, initiated in 1978, are reported. Routinely analyzed were 27 aromatic hydrocarbons, 13 chlorinated pesticides, 37 metals, polychlorinated biphenyls (PCB), and chlorobutadienes in sediments and organisms. The highest mean contaminant levels in sediments and sole livers, respectively, were: PCB, 380 ppb and 35,000 ppb; total chlorobutadienes, 1600 ppb and 9100 ppb; hexachlorobenzene, 74 ppb and 3700 ppb. Total aromatic hydrocarbons levels reached a high of 13,000 ppb (mean value). Highest trace metals concentrations were: Hg, 1900 ppb; Pb, 630,000 ppb; As, 470,000 ppb; and Cd, 18,000 ppb. A large variety of histopathological conditions were observed among fish, shrimp, and crabs collected in the most heavily polluted sites, Elliott and Commencement Bays, near the urban centers of Tacoma and Seattle. Species compositions of marine fauna also reflected the pollution levels. Findings of this study show that the marine resources of Puget Sound, perceived as clean by consumers, are highly contaminated by toxic chemicals in some areas. (Cassar-FRC)
W84-00159

THE USE OF STRONTIUM-87/STRONTIUM-86 RATIOS TO MEASURE ATMOSPHERIC TRANSPORT INTO FORESTED WATERSHEDS,
Yale Univ., New Haven, CT. Dept. of Geology and Geophysics.
W. C. Graustein, and R. L. Armstrong.
Science, Vol 219, No 4582, p 289-292, January 21, 1983. 1 Fig, 3 Tab, 12 Ref.

Descriptors: *Strontium, *Nutrients, *Aerosols, Tracers, Fate of pollutants, *Forest watersheds, *Air pollution, Trees, Spruce trees, Aspen trees, Bedrock, Weathering, Deposition, Leaves, *New Mexico, Sangre de Cristo Mountains.

The Sr87/Sr86 ratio was used as a tracer to determine the sources of Sr in natural waters, vegetation, and soils in two small forested watersheds, one covered with aspen and the other with Engelmann spruce and subalpine fir, in the Sangre de Cristo Mountains, New Mexico. This mountain range, 1.6 billion years old, has a higher Sr87/Sr86 ratio than the surrounding, lower terrain, 0.6 billion years old, from which atmospheric Sr aerosols and dust are deposited on vegetation. Dust input from remote areas provided 75% of the Sr in the aspen vegetation; 80% in the spruce vegetation. The remainder of the Sr is derived from weathering of bedrock. The conifers intercepted most of the Sr-bearing aerosol in the watershed; very little was trapped by the deciduous foliage. Sr and nutrients are cycled continuously through a system consisting of upper soil horizons, forest litter, and vegetation. (Cassar-FRC)
W84-00176

SOIL SOLUTE CONCENTRATION DISTRIBUTIONS FOR SPATIALLY VARYING PORE WATER VELOCITIES AND APPARENT DIFFUSION COEFFICIENTS,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
For primary bibliographic entry see Field 2G.
W84-00188

AN EVALUATION OF SELECTED HALOCARBONS AND TRACE GASES FOR POTENTIAL USE AS INDICATORS OF GROUNDWATER MOVEMENT AND SOURCE (AND CONTAMINANT MOVEMENT IN THE VADOSE ZONE),
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
D. K. Kreamer.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-117266, Price codes: A03 in paper copy, A01 in microfiche. Arizona Water Resources Research Center Completion Report, March 1983. 26 p, 7 Fig, 2 Tab, 4 Ref. OWRT A-111-ARIZ(1), 14-34-0001-1103.

Descriptors: *Tracers, Tracking techniques, *Indicators, Path of pollutants, Pollutants, Water pollution, *Groundwater movement, *Groundwater pollution, Vadose zone, Halocarbons.

Selected trace gases were evaluated as indicators of groundwater movement and source. Measurable quantities of trichloroethylene (TCE), perchloroethylene (PCE), 1,1,1-trichloroethane (TCA), chloroform (CC1 sub 3 H), trichlorofluoromethane (F-11), methylene chloride (CH sub 2 C1 sub 2), carbon tetrachloride (CC1 sub 4), and other trace gases were found in the gaseous component of the vadose zone. A technique was developed to use these compounds in the gas phase as indicators of groundwater pollution and contaminant migration. TCE was found in concentrations of 0.7 and 8.5 mu g/l respectively for the Phoenix well 35 and Salt River Project well 23.6E-6N, at respective depths of 9.3 and 17.8 feet below ground surface, (approximately 200 and 70 feet above the saturated zone). Halocarbons were measured in the atmosphere above ground, in the gaseous phase at depths of 10, 20, 50, and 90 feet below land surface, and in the groundwater at the Carranza well, Tucson, Arizona. TCE, CC1 sub 4, PCE, and CC1 sub 3 H showed gradients that increased in concentration toward the water table, indicating a local subsurface of water table source. F-11, TCA, and CH sub 2 C1 sub 2 showed decreasing concentration with depth indicating a possible atmospheric origin. Distribution coefficients between water and gaseous phases were found to be higher in field conditions as compared to laboratory conditions for F-11, CHC1 sub 3, CC1 sub 4, and PCE, and lower for TCE and CH sub 2 C1 sub 2.
W84-00201

TRACE METAL CONTAMINATION OF SHALLOW MARINE SEDIMENTS NEAR A LEAD SMELTER, SPENCER GULF, SOUTH AUSTRALIA,
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Fisheries and Oceanography.
T. J. Ward, and P. C. Young.
Australian Journal of Marine and Freshwater Research, Vol 32, No 1, p 45-46, 1981. 3 Fig, 6 Tab, 13 Ref.

Descriptors: *Fate of pollutants, *Water pollution sources, *Heavy metals, *Marine sediments, *Bays, Industrial wastes, Organic carbon, Cadmium, Calcium, Copper, Minerals, Magnesium, Manganese, Nickel, Lead, Zinc, Silt.

The surface (<10 cm) marine sediments of Spencer Gulf, a hypersaline seagrassed embayment, near Port Pirie, South Australia, were examined for concentrations of calcium, cadmium, copper, magnesium, manganese, nickel, lead, zinc, total organic carbon, clay, silt, sand, shell, and 'undissolved fraction' (resistant plant debris). Elevated concentrations of lead, copper, zinc, manganese and cadmium were found in sediments adjacent to the liquid effluent discharge from a lead smelter. Outside the immediate discharge area the concentrations of copper and manganese rapidly approached background levels where their concentrations were correlated to those of noncontaminant sediment parameters. The highest concentrations of cadmium were found further from the source of effluent than those of the other four contaminant metals (copper, manganese, lead, zinc), and decreased to undetectable levels at the furthest site. Lead and zinc also occurred at background concentrations at sites away from the effluent discharge, but no correlations were found between these two metals and other sediment parameters. At sites away from the immediate discharge area no interaction was detected between contaminant metals, sediment parameters, and presence or type of seagrass meadow. (Author's abstract)
W84-00312

MUTAGENICITY OF POTENTIAL EFFLUENTS FROM AN EXPERIMENTAL LOW BTU COAL GASIFIER,
Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM. Inhalation Toxicology Research Inst.
J. M. Benson, C. E. Mitchell, R. E. Royer, C. R. Clark, and R. L. Carpenter.
Archives of Environmental Contamination and Toxicology, Vol 11, No 5, p 547-551, 1982. 1 Fig, 5 Tab, 17 Ref.

Descriptors: *Coal gasification, *Mutagenicity, *Industrial wastes, Public health, Design criteria, Organic compounds, Salmonella strain TA98, Salmonella.

Mutagenicity of potential waste effluents produced by an experimental low Btu coal gasifier was studied in Salmonella strain TA98. Samples studied included producer bottom ash and cyclone dust with little associated organic matter, tars, and water containing organic compounds condensed from the process stream. The organic compounds present in potential waste effluents, except for bottom ash, were mutagenic in Salmonella strain TA98. Except in the case of LH-20 fractions from tar-trap tar, metabolic activation was required for a mutagenic effect. These results indicate that potential gasifier effluents contain compounds which, following metabolism, become frameshift mutagens; others may also be formed. Results of chemical fractionation studies indicate that neutral and polar polycyclic aromatics contributed to the mutagenicity, although in the case of tar-trap tar, other classes of compounds also contributed to the biological activity. Potential health hazards associated with these findings should be considered in the design of future coal gasification facilities. (Baker-FRC)
W84-00317

HEAVY METAL ABSORPTION BY WINTER WHEAT FOLLOWING TERMINATION OF CROPLAND SLUDGE APPLICATIONS,
California Univ., Riverside. Dept. of Agriculture.
A. C. Chang, A. L. Page, and F. T. Bingham.
Journal of Environmental Quality, Vol 11, No 4, p 705-708, October-December, 1982. 7 Tab, 17 Ref.

Descriptors: *Metals, *Sludge disposal, *Sand application, Wheat, Cadmium, Zinc, Heavy metals, Land disposal, Fate of pollutants.

Municipal sludge was applied to a test plot near Rio Vista, California, from 1973 through 1976, at the rate of 33, 66, 107, and 147 tons per ha. Total inputs of heavy metals at the highest application rate (kg per ha) were: Cd, 6.24; Cu, 86.2; Ni, 20.6; Pb, 148.2; and Zn, 567.0. Soils and winter wheat crops were sampled in 1979 and 1980. Grain yields from the land treated with 147 tons per ha of sludge were significantly higher than from control plots. Metals contents (micrograms per g) were: wheat straw--Cd, 0.07-0.16; Zn, 19-26; wheat grain--Cd, 0.04-0.09; Zn, 22-45. These values were slightly higher than in controls but were well within the range typical for wheat grown on uncontaminated soils. Levels of Cu, Ni, and Pb were not elevated in the plant tissue. Added metals were confined almost entirely to the 0 to 15 cm soil layer, in which they were incorporated by plowing. Cd appeared to have a greater tendency to migrate than the other metals. Acidity, electrical conductivity, and water-extractable Cd and Zn levels of the soil were not changed by the sludge treatments. (Cassar-FRC)
W84-00328

OPTIONS FOR HANDLING STILLAGE WASTE FROM SUGAR-BASED FUELS ETHANOL PRODUCTION,
East-West Environment and Policy Inst., Honolulu, HI.
I. P. Willington, and G. G. Marten.
Resources and Conservation, Vol 8, No 2, p 111-129, 1982. 1 Fig, 3 Tab, 9 Ref.

Descriptors: *Industrial waste, *Waste disposal, *Fuel, Stillage processing wastes, Ethanol production, Water pollution sources, Sugars, Hawaii.

Stillage waste from ethanol fuel production can be a serious source of water pollution but it can also be a valuable resource from which to recover useful products such as fertilizer, animal feed, or methane gas. Various possibilities for stillage handling include discharge to adjacent waterway or land area, marine outfall, return to agricultural fields, conventional sewage treatment, lagoon treatment, anaerobic digestion with methane production, incineration to ash for subsequent use as fertilizer, and evaporation to an animal feed. These options vary enormously in their environmental characteristics and the degree to which they are commercially proven, consume or produce energy, lead to useful by-products and cost or generate money. The cost depends on the wastewater characteristics, applicable ambient and emission standards, energy requirements of the distillery, economics, availability and cost of land, and the location of the distillery relative to receiving waters and byproduct markets. The environmental impacts of alcohol stillage upon water quality and the aquatic ecosystem include depletion of dissolved oxygen, discoloration, odors, eutrophication, salinization, acidification, increases in water temperature, changes in species composition of aquatic flora and fauna, and fish kills in extreme cases. The formation of a clearing-house for stillage processing information is proposed to offer assistance to those in need of making the many decisions regarding proper disposal of stillage waste products. (Baker-FRC)
W84-00330

ACCUMULATION OF HEAVY METALS IN UNICELLULAR ALGAE,
Monash Univ., Clayton (Australia). Dept. of Chemical Engineering.
D. Khummongkol, G. S. Canterford, and C. Fryer.
Biotechnology and Bioengineering, Vol 24, No 12, p 2643-2660, December, 1982. 9 Fig, 2 Tab, 33 Ref.

Descriptors: *Accumulation, *Heavy metals, *Model studies, *Fate of pollutants, Algae, Microorganisms, Bioaccumulation, Adsorption, Metals, Phosphates, Cadmium.

A model for metal uptake by microorganisms based on surface adsorption was formulated and applied to cadmium (Cd) uptake by Chlorella vulgaris. When cell growth is modeled, an initial rapid uptake and a subsequent slow uptake is predicted due to the simultaneous effects of growth and surface adsorption. Experimental results in a batch system confirm the rapid initial uptake of metals within a few seconds. This equilibrium is affected by phosphate concentration; the amount of CD adsorbed on the cell decreases as the phosphate level increases. Long-term uptake experiments in growing cultures show a greater metal accumulation than predicted by the adsorption model suggesting the involvement in the slow long-term uptake of some mechanism other than adsorption. A model which incorporates a description of adsorption and of intracellular accumulation is needed to provide a more complete description of metal uptake by microorganisms. (Geiger-FRC)
W84-00331

BIOAVAILABILITY OF PHOSPHORUS INPUTS TO LAKES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
W. C. Sonzogni, S. C. Chapra, D. E. Armstrong, and T. J. Logan.
Journal of Environmental Quality, Vol 11, No 4, p 555-563, October-December, 1982. 2 Fig, 2 Tab, 16 Ref.

Descriptors: *Phosphorus, *Eutrophication, *Lakes, Phosphates, Water pollution sources, Fate of pollutants, Reviews, Algae, Sediment, Adsorption, Desorption, Water quality management, Agricultural runoff, Suspended sediments, Pollutant identification.

Current information on the bioavailability of forms of phosphorus delivered to lakes from different sources is reviewed with attention to management implications. Dissolved P is readily available for use by algae and higher plants, either directly (inorganic P) or readily convertile (condensed P and organic P). Particulate P is partially available for biological use in the inorganic form (nonapatite inorganic P) and convertile to dissolved reactive P in the organic and condensed forms. Inorganic P in the apatite inorganic form is essentially unavailable. Methods of analyzing for bioavailable inorganic P are described. Potentially available P corresponds with the dissolved reactive P (DRP) plus the fraction of particulate inorganic P obtained by extraction with 0.1 N NaOH. Natural factors influencing bioavailability include the rate of P release from suspended particles, the rate of settling of suspended particles, the equilibrium concentration of DRP, algal uptake, and phosphate desorption rates. Potential bioavailability has been estimated at 20-80% of total P input, usually in the lower part of the range. P sources include agricultural and urban runoff, water and wind erosion, fertilizers, atmospheric deposition, and wastewater effluents. Management programs for lakes should consider bioavailability of P to avoid costly overcontrol of P inputs. Most efficient P management should attack the sources highest in DRP: municipal point discharges and excessive fertilizer application. (Cassar-FRC)
W84-00336

EVALUATION OF NITROGEN AND IRRIGATION MANAGEMENT FOR CORN PRODUCTION USING WATER HIGH IN NITRATE,
Nebraska Univ.-Lincoln. Dept. of Agricultural Engineering.
D. L. Martin, D. G. Watts, L. N. Mielke, K. D. Frank, and D. E. Eisenhauer.
Soil Science Society of America Journal, Vol 46, No 5, p 1056-1062, September/October, 1982. 8 Fig, 1 Tab, 8 Ref.

Descriptors: *Nitrogen, *Crop yield, *Groundwater pollution, *Irrigation, Nitrates, Fertilizers, Corn, Groundwater management, Nitrogen uptake.

The interaction of N and water management for corn production was studied using a field-calibrated computer model. The study was conducted on sandy soils in the central Platte Valley of Nebraska. Nitrogen uptake was strongly influenced by the amount of fertilizer N and irrigation water applied and to a lesser extent by the nitrate-nitrogen concentration of the irrigation water. There was also a strong interaction of these parameters in determining N uptake. The uptake efficiency of fertilizer N was very sensitive to excess irrigation and only slightly affected by the amount of fertilizer applied or the nitrate-nitrogen concentration of the irrigation water. The uptake efficiency of groundwater N was strongly affected by the amount of irrigation water applied and the nitrate-nitrogen concentration of the water, while the amount of fertilizer applied had a lesser effect. Groundwater uptake efficiencies in general were higher and more stable than fertilizer uptake efficiencies. Excess irrigation increased N uptake from groundwater sources under certain conditions. The groundwater N contribution to uptake was large for irrigation water containing more than 10 ppm nitrate-nitrogen and was primarily determined by the amount of irrigation and the nitrate-nitrogen concentration. For 25 ppm nitrate-nitrogen irrigation water and small fertilizer applications more N was extracted from the groundwater through irrigation than was lost due to leaching. (Baker-FRC)
W84-00344

5C. Effects Of Pollution

FEASIBILITY AND EFFECTS OF WATER QUALITY ON BAIT-FISH CULTURE IN AERATED SEWAGE TREATMENT LAGOONS IN VERMONT,
Vermont Univ., Burlington.
G. W. LaBar.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110790, Price codes: A02 in paper copy, A01 in microfiche. Vermont Water Resources Research Center Completion Report, September 1983. 11 p, 1 Tab, 14 Ref. OWRT A-044-VT(1).

Descriptors: Wastewater, *Aquaculture, Water quality, *Lagoons, *Vermont, Sewage treatment, *Shiners.

Golden shiners (Notemegonus chrysoleucas) were successfully cultured in 1 m super 3 floating cages in the final lagoon of an aerated lagoon-type sewage treatment facility in Milton, Vermont. The mortality rate at densities of 50 and 100/m super 3 was 6% and 8% respectively, and at 200/m super 3 was 34% over a two-month period. Zinc concentration increased from 2.0 to 6.6 ppm during the same period, while cadmium, lead, and chromium concentrations did not change significantly.
W84-00006

CELLULAR BIOASSAY OF FISH AS A SENSITIVE INDEX OF WATER QUALITY RELATED TO ASH FROM COAL COMBUSTION,
West Virginia Univ., Morgantown. Water Research Inst.
D. E. Hinton, E. R. Walker, and D. M. Kontir.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110824, Price codes: A05 in paper copy, A01 in microfiche. Completion Report, 1983. 78 p, 12 Fig, 9 Tab, 53 Ref. OWRT A-045-WV(1), 14-34-0001-2152.

Descriptors: *Acid mine water, Analysis, *Analytical techniques, *Bituminous coal, *Cytological studies, Fish, *Fly ash, Methodology, Trace elements, Water Quality, Burning, Chemical Analysis, Electric powerplants, Energy, Evaluation, Metals, Water pollution, *Bioassay, *Trout.

Static exposure of aqueous suspensions of ash from coal combustion to Oryzias latipes (embryo), Pimephales promelas, and Salmo gairdoeri (adults) was done to determine whether cells of gill, gut, and/or lateral-line system could phagocytose particulates. Energy dispersive X-ray microanalysis of specific cells in gill did not reveal presence of particulates after exposure. Studies on intestine and lateral line are continuing. Effects of uptake of one coal associated polynuclear aromatic, 3-methylcholanthrene (3-MC), were studied in trout liver by a coupled structure/function approach. 3-MC caused induction of liver microsomal benzo(a)pyrene (BP) hydroxylasse activity but did not affect epoxide hydrase activity. In-vitro microsomal metabolism of BP was qualitatively and quantitatively altered by prior 3-MC exposure. No morphologic alternations accompanied biochemical changes. Field studies to assess effects of coal combustion byproducts on feral fish tissues and enzymes are continuing.
W84-00009

PLANKTON AND BENTHIC INSTREAM-FLOW CRITERIA, STRATEGY, AND HABITAT DELINEATION IN ACID-CONTAINING WATERS,
West Virginia Univ., Morgantown. Water Research Inst.
E. C. Keller, Jr.,, D. K. Werner, R. B. Gerber, and A. J. Becker.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110840, Price codes: A05 in paper copy, A01 in microfiche. Completion Report, 1983. 87 p, 38 Fig, 25 Tab, 46 Ref, 1 Append. OWRT A-048-WVA(1), 14-34-0001-2152.

Descriptors: *Acid mine drainage, *Aquatic habitats, *Benthos, *Chemical properties, *Data interpretation, *Instream flow, *Plankton, Streamflow, Water quality, *Water quality standards, Acid streams, Acidic water, Aquatic life, Assessments, Benthic fauna, Benthic flora, Ecology, Ecosystems, Mine drainage, *West Virginia, Pennsylvania.

Eight homogenous river segments were identified, through cluster analysis, in the upper Monogahela River Basin viz, Cheat Lake, Tygart Lake, an acid drainage segment of the middle Cheat, the lower Monongahela (to Pt. Marion, PA), the upper Monongahela, the upper Cheat, the lower Blackwater River, and the Westfork River (south to Clarksburg, WV). Regression analyses of data from within these segments indicated that instream flow was highly associated with Total Algal Biomass in several of the segments. Regression analyses also showed that instream flow had very little association with the Algal Genera Distribution. The segmental approach to determine these algal associations with instream flow was an extremely effective approach, since considerably more variation in Total Algal Biomass could be explained using the segmental approach as compared with the use of all of the variable data. Five variables showed a general positive association with general instream flow in the basin viz, calcium, conductivity, hardness, magnesium, and dissolved oxygen. Consistent temporal changes in water quality occurred throughout the upper Monongahela River basin within the three sub-basins viz, the Monongahela, the Tygart Valley, and the Cheat Rivers, some fourteen variables showed consistently increasing trends and 14 showed consistently decreasing trends.
W84-00011

FOOD CHAIN ENRICHMENT OF ORGANOCHLORINE COMPOUNDS AND MERCURY IN CLEAN AND POLLUTED LAKES OF FINLAND,
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W84-00023

EFFECTS OF CADMIUM ON STREAMS AND IRRIGATED AGRICULTURE IN THE PRESENCE AND ABSENCE OF OIL SHALE LEACHATE,
Utah Water Research Lab., Logan.
D. A. Selby, J. M. Ihnat, F. J. Post, and J. J. Messer.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111707, Price codes: A08 in paper copy, A01 in microfiche. Water Quality Series UWRL/Q-83/08, August 1983. 148 p, 28 Fig, 26 Tab, 216 Ref, 2 Append. OWRT B-214-UTAH(1), 14-34-0001-1280.

Descriptors: *Oil shale, *Leachate, *Cadmium, *Alfalfa, *Chelation, Environmental effects, Crop production, Stream microcosms, Aufwuchs, Invertebrates, Substrates, Benthic environment, Benthic fauna, Nitrification, Utah, Colorado, Water pollution effects.

The goal of this study was to identify potential effects should oil shale leachates in Utah and Colorado reach hardwater stream ecosystems or irrigate agricultural lands. The experimental work focused on interactions between raw oil shale leachate and heavy metals in concentrations naturally occurring in these streams and how these interactions affect the toxicity and bioaccumulation of metals. For the studies on hardwater streams, eight identical stream microcosms were constructed and allowed to establish self-sustaining communities of aufwuchs and invertebrates on natural river substrates. Pairs of streams were exposed to treatments of 20 ug Cd/1 representing the most severe likely concentration in the natural streams), 20 ug Cd/1 plus leachate from crushed raw oil shale, and crushed raw oil shale leachate alone. The other two streams were controls. After three weeks, sampling was conducted to determine changes in community structure and observe biological cadmium accumulation. Clorophyll ratios, aufwuchs biomass, invertebrate density, and invertebrate drift showed no measureable effects. However, cadmium accumulations were recorded in aufwuchs, macro-phytes, invertebrates grazers, particulate feeders, predators, and stream sediments but not affected by the oil shale leachate. Cadmium accumulations by aufwuchs are largely associated with cellular surfaces. Effects of oil shale leachate on cadmium toxicity and accumulation in crops were studied using alfalfa and radish plants with the same four treatments. The plants accumulated up to 4.0 ug/g dry weight cadmium, and slightly higher cadmium accumulations occurred with oil shale leachate. None of the treatments affected crop productivity.
W84-00030

THE INDUCTION OF TOLERANCE TO HEAVY METALS IN NATURAL AND LABORATORY POPULATIONS OF FISH,
Kentucky Water Resources Research Inst., Lexington.
W. J. Birge, W. H. Benson, and J. A. Black.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111756, Price codes: A03 in paper copy, A01 in microfiche. Research Report No 141, June, 1983. 31 p, 1 Fig, 8 Tab, 29 Ref. OWRT A-087-KY(1), 14-34-0001-2119(FY82).

Descriptors: *Cadmium, *Copper, Embryos, Larvae, Water quality, Zinc, *Heavy metals, Water pollution effects, Acclimation, *Toxicity tests, *Bioaccumulation, Fathead minnow, Tolerance.

Aquatic toxicity studies were performed on two natural populations of fathead minnows. One group of organisms was taken from a metal-contaminated flyash pond associated with a coal-fired power plant and the other group was collected from relatively uncontaminated hatchery ponds. Acute tests indicated that flyash pond fish were significantly more tolerant to cadmium and copper than were hatchery fish. As an exposed concentration of 6.0 mg Cd/L in moderately hard water, the median period of survival for flyash pond fish was 50.0 hr compared to 6.8 hr for hatchery fish. Both groups of organisms were about equally sensitive to zinc. The metal-induced tolerance observed with animals from the flyash pond was not a sustained response. Additional studies were undertaken to observe the response of laboratory populations of fathead minnows to acutely toxic cadmium concentrations following acclimation to sublethal exposures of this metal. Based on 96-hr LC sub 50 values, those animals which had recieved 35-days prior exposure to 10 and 50 ug CD/L were 63 to 68% more tolerant to cadmium than were previously unexposed organisms. As with the natural population, tolerance to cadmium in the laboratory fish was not retained. After organisms which had been acclimated to 1o ug Cd/L were transfered to clean water, tolerance to cadmium decreased by three and one-half fold after only 7 days. Developing embryos of the fathead minnow and rainbow trout also acquired tolerance to cadmium. After eggs of the trout had been exposed to 0, 5, and 50 ug Cd/L for 24 days, subsequent acute toxicity tests gave 7-day LC sub 50 values of .7, 1, 59, and 2.02 ug Cd/L, respectively.
W84-00035

RECOVERY PATTERNS IN STREAM COMMUNITIES IMPACTED BY THE MT. ST. HELENS ERUPTION,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
P. Wilzbach, T. L. Dudley, and J. D. Hall.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111798, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Institute Publication WRRI-83, Oregon State Univ., Corvallis, August 1983. 33 p, 6 Fig, 6 Tab, 11 Ref, 2 Append. OWRT A-059-ORE(1), 14-34-0001-2139.

Descriptors: *Stream recovery, *Stream habitats, *Habitat recovery, *Stream biological communities, Stream biota, Stream fisheries, Aquatic habitats, *Aquatic habitat recovery, Benthic communities, Sedimentation, Channel erosion, Channel scour, Channel morphology, *Mt. St. Helens, *Washington.

Recovery patterns of benthic communities in seven small streams impacted to varying degrees by the eruption of Mt. St. Helens were examined in winter 1981-82, particularly in relation to habitat constraints. Overall abundance and diversity of the communities were low, and instability of channel banks appears to severely limit re-establishment of biota. Communities appear to be undergoing cycles of establishment and denudation in concert with changes in landscape geomorphology. Disturbance events of varying frequencies were also simulated in experimental stream channels to more closely evaluate the response of benthic communities to periodic, non-catastrophic disturbances and to compare this with the response observed to catastrophic perturbation associated with volcanic eruption. Results of simulations suggest that non-catastrophic disturbances may not play a major role in determining stream community over ecological time because the predictability of these events may have enabled evolution in species of adaptive responses to cope with disturbance. Catastrophes appear to have different consequences on stream communities from other disturbances and should be distinguished from them.
W84-00039

THE EFFECTS OF AGRICULTURAL RUNOFF UPON NATURAL WETLAND ECOSYSTEMS,
Concordia Coll., Moorhead, MN. Dept. of Biology.
G. L. Vanamburg.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111905, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Completion Report, Univ. of Minnesota, St. Paul, September 1983. 40 p, 15 Fig, 8 Tab, 22 Ref. OWRT A-044-MINN(1), 14-34-0001-2125.

Descriptors: *Wetlands, *Agricultural Runoff, *Fertilizers, Nutrients, Productivity, *Minnesota, *Marshes, Ammonia, Nitrogen, Ecosystems.

The purpose of the study was to examine the functioning of the major wetland ecosystem compartments. Two prairie glacial marshes in western Minnesota were studied. The major compartments studied were: (1) watershed soils, (2) watershed runoff, (3) emergent macrophytes, (4) submergent plants, (5) wetland sediment, and (6) wetland waters. Ammonia and nitrate forms of nitrogen contributed significantly to nitrogen entering the wetlands via runoff. Above ground biomass of Typha peaked in mid July ranging from 650 to 988 g/m super 2. Below ground biomass reached a maximum in June, declined until late summer, then recovered to values recorded in early spring. Nitrogen concentrations in Typha shoots increased in early spring then declined throughout the season. Nitrogen concentration of the rhizomes and roots was less than in the shoots, except late in the season. Nitrogen content declined in the rhizomes and roots until mid July, after which N-concentration increased in the rhizomes. Changes in Phosphoros concentration in the shoots, rhizomes and roots were very similar in pattern to nitrogen. Total non-structural carbohydrate concentration in rhizomes and roots declined until mid July, then began increasing. One wetland was dominated by Potamogeton pectinatus, which reached a peak standing crop biomass of 264 g/m super 2 on August 10. The other wetland had Ceratophyllum demersum and P. berchtoldii as co-dominant species. P. berchtoldii reached a maximum standing crop of 128 g/m super 2 on June 30, while C. demersum peaked at 127 g/m super 2 on July 28.
W84-00050

ACCUMULATION OF CADMIUM IN A FRESHWATER FOOD CHAIN EXPERIMENTAL MODEL,
Metz Univ. (France). Toxicology Lab.
J. F. Ferard, J. M. Jouany, R. Truhaut, and P. Vasseur.
Ecotoxicology and Environmental Safety, Vol 7, No 1, p 43-52, 1983. 8 Fig, 4 Tab, 11 Ref.

Descriptors: *Biological magnification, *Bioaccumulation, *Water pollution effects, Fish, *Daphnia, *Chlorella, *Food chains, Crustaceans, Heavy metals, Cadmium, Metals, Algae, Trophic level.

The study of food chain contamination in the laboratory or in nature requires the precise definition of certain terms. An elaborated version of a freshwater food chain model was applied to assess the hazards of cadmium in the aquatic environment. Chlorella algae were exposed to various levels of cadmium for 10 days in Erlenmeyer flasks and were then fed to the second trophic level of Daphnia magna for 20 days. Leucaspius delineatus comprised the third trophic level of fish, which were allowed to feed on the daphnids for 4 days. Toxicity of cadmium to daphnids was measured in terms of mortality, reproduction and total body levels of the heavy metal. Total cadmium levels were also recorded for algae and fish tissues. Results showed a high direct bioaccumulation of cadmium in algae and an indirect bioaccumulation of the same order of magnitude in daphnids. Although the indirect bioaccumulation of cadmium in fish was much smaller, the transfer of the metal from daphnids to fish was obvious. (Geiger-FRC)
W84-00074

THE SIGNIFICANCE OF THE ACCUMULATION OF CADMIUM BY AQUATIC ORGANISMS,
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
D. Taylor.
Ecotoxicology and Environmental Safety, Vol 7, No 1, p 33-42, 1983. 2 Fig, 63 Ref.

Descriptors: *Water pollution effects, *Bioaccumulation, *Cadmium, *Literature review, Crustaceans, Biological magnification, Heavy metals, Metals, Reviews, Mollusks, Gastropods, Aquatic animals.

Cadmium appears on many lists of substances dangerous to aquatic life by virtue of its toxicity at low levels, its persistence and its ability to bioaccumulate. A review of forty laboratory studies on cadmium bioconcentration suggests that the bioaccumulation potential of this heavy metal appears to

have been somewhat exaggerated. Median concentration factors for both marine and freshwater organisms are 100 times; for vertebrate species including fish, concentration factors are 20 times. Bioaccumulation of cadmium by aquatic animals is affected by the speciation of the metal in the aquatic environment, certain abiotic factors such as temperature, salinity, and water hardness, the route of entry of cadmium into the animal, and the action of synergistic and antagonistic substances. There is no evidence in the literature for the biomagnification of cadmium, and the bioconcentration of the metal is only likely to be of significance in a restricted range of gastropod mollusks and some crustacea. (Geiger-FRC)
W84-00075

PRODUCTION OF FILTER-FEEDING TRICHOPTERA IN AN IMPOUNDED AND A FREE-FLOWING RIVER,
Royal Ontario Museum, Toronto. Dept. of Entomology.
For primary bibliographic entry see Field 6G.
W84-00079

TOXICOLOGICAL EFFECTS OF DEHYDROABIETIC ACID (DHAA) ON THE TROUT, SALMO GAIRDNERI RICHARDSON, IN FRESH WATER,
Helsinki Univ. (Finland). Dept. of Zoology.
A. Oikari, B. E. Lonn, M. Castren, T. Nakari, and B. Snickars-Nickinmaa.
Water Research, Vol 17, No 1, p 81-89, January, 1983. 5 Tab, 41 Ref.

Descriptors: *Water pollution effects, *Fish, *Toxicity, *Dehydroabietic acid, Industrial wastes, Effluents, Pulp and Paper industry.

Toxicological and physiological effects of dehydroabietic acid (DHAA), a major poison to fish in pulp and paper mill effluents, were studied by two experiments using rainbow trout, Salmo gairdneri Richardson. In the first experiment fish were acutely exposed for 4 days to an average DHAA concentration of 1.2 mg/liter. In the second the fish were exposed for 30 days to an average of 20 micrograms DHAA per liter. Compared to the controls, fish of experiment 1 displayed a decreased relative weight of liver, increased blood hematocrit, increased hemoglobin, and increased plasma protein concentrations. The aspartate aminotransferase activity of heart muscle was significantly elevated, as was also the lactate dehydrogenase (LDH) of white muscle tissue. In the blood plasma the proportion of muscle-type LDH activity was simultaneously increased. UDP-glucuronyltransferase activities of liver and kidney were strongly decreased. Results suggest an increased and altered use of body energy reserves, decreased plasma volume and impaired liver function. Fish of experiment II showed an increased relative weight of spleen. In addition, liver and gill LDH shifted towards heart-type. It was concluded that 20 micrograms/liter is close to the minimum effective concentration of DHAA for rainbow trout. (Baker-FRC)
W84-00094

THE PERFORMANCE OF A NEW BIOLOGICAL WATER QUALITY SCORE SYSTEM BASED ON MACROINVERTEBRATES OVER A WIDE RANGE OF UNPOLLUTED RUNNING-WATER SITES,
Freshwater Biological Association, Wareham (England). River Lab.
P. D. Armitage, D. Moss, J. F. Wright, and M. T. Furse.
Water Research, Vol 17, No 3, p 333-347, March, 1983. 5 Fig, 8 Tab, 29 Ref.

Descriptors: *Monitoring, *Invertebrates, *Aquatic habitats, Water pollution effects, Water quality, Biological monitoring working party, Species composition, Rivers, Habitats, Macroinvertebrates, Aquatic populations, Classification indexes, Environmental effects.

The Biological Monitoring Working Party (BMWP) system of assigning scores to aquatic habitats was evaluated using macroinvertebrate population data from 268 sites in 41 British rivers varying widely in physical and chemical features. Water quality in the sites was good or fairly good. The BMWP score system ranges from 1, indicating poor water quality, to 10, indicating excellent water quality. Seasonal variation in scores was relatively small, and samples taken in spring, summer, or autumn should give similar average scores per taxon (ASPT), derived from score divided by total number of scoring taxa. Sample replication had little effect on ASPT. Data on BMWP score and ASPT values for 8 groups of sites derived by multivariate classificatory techniques produced considerable variability in achievable score and ASPT. High BMWP scores were most common in the middle reaches; ASPT scores were usually highest in the upper reaches of upland rivers. Shoreline samples had higher scores than midstream samples. ASPT scores also showed differences between sites with similar BMWP scores but different physical and chemical characteristics. Equations for predicting BMWP scores and ASPT were developed to predict theoretical scores for given physical, chemical, and environmental conditions. These equations explained 65% and 22% of the variance for ASPT and BMWP scores, respectively. (Cassar-FRC)
W84-00130

EXPERIMENTAL ESTIMATE OF THE TOXICITY OF DANUBE WATER FOR DAPHNIA MAGNA STRAUS,
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
E. P. Shcherban.
Hydrobiological Journal, Vol 18, No 2, p 81-87, 1982. 1 Fig, 3 Tab, 18 Ref.

Descriptors: *Rivers, *Toxicity, *Turbidity, Pollutant identification, Suspended sediments, Danube River, Daphnia magna, Water quality, Monitoring, Water management, *USSR.

Toxicity of Danube water was studied in both acute and chronic experiments of Daphnia magna Straus. No acute toxicity was observed during the study. When the water was exchanged, death of the crustaceans may have been due to a lack of adaptation to turbid Danube water. During certain periods a sharp increase was noted in toxicity of Danube water, indicating nonuniformity of the influx of toxicants and peaks of pollution. The chronic effect of native Danube water leads to a reduction in the duration of life of the daphnia, a lengthening of their post-embryonal development, and a decrease in the fecundity of daphnia over several generations. The toxicity of Danube water apparently results from the presence of impurities, turbid suspensions, as well as certain toxicants. (Baker-FRC)
W84-00145

SANITARY MICROBIOLOGIC EVALUATION OF THE QUALITY OF COASTAL MARINE WATERS POLLUTED BY INDUSTRIAL AND DOMESTIC WASTES (OSOBENNOSU SANITARNO-MIKROBIOLOGESKOI OTSENKI KACHESTVA PRIBREZHNYKH MORSKOI VOD V USLOVIYAKHI IKH PROMYSHLENNO-BYTOVOGO ZAGRYAZNENIYA),
Institute of General and Municipal Hygiene, Moscow (USSR).
G. A. Bagdasarian, Yu. G. Talaeva, T. Z. Artemova, and A. E. Nedachin.
Gigiena i Sanitariia, No 8, p 5-8, August, 1980. 5 Ref.

Descriptors: *Marine environment, *Microorganisms, *Bioindicators, *Water pollution, Marine biology, Microbiological studies, Viruses, Epidemiology, Seawater, Water pollution effects, *USSR.

Interactions between biological (microbial) and chemical contaminants in marine waters as well as survival patterns of pathogenic and sanitary indicator microorganisms in these waters were studied. The quantitative relationships established in field studies between indicator microorganisms and isolation rates of pathogens of bacterial and viral origin from marine waters made it possible to determine precisely the permissible levels of indicator microorganisms. Indicator organisms characterize the degree of epidemiologic safety of the waters polluted by industrial and domestic sources. (Author's abstract)
W84-00149

EFFECTS OF OIL ON PHYTOPLANKTON METABOLISM IN NATURAL AND EXPERIMENTAL ESTUARINE PONDS,
Mississippi State Univ., Mississippi State. Dept. of Biological Sciences.
A. A. De la Cruz.
Marine Environmental Research, Vol 7, No 4, p 257-263, 1982. 2 Tab, 16 Ref.

Descriptors: *Phytoplankton, *Oil spills, *Estuaries, Water pollution effects, Aquatic plants, Metabolism, Oil pollution, Oil, *Mississippi, *Marsh ponds, Ocean Springs, St. Louis Bay.

A low level oil spill was simulated in small shallow natural estuarine marsh ponds in Ocean Springs and in experimental impoundments near St. Louis Bay, Mississippi. The oil used in the study was Empire Mix crude oil. It is a low sulfur oil and typifies the type of oil pumped along the US Gulf Coast. A simulated spillage of 1.45 mg per liter of water was made. Within 2 hr after the spill the pond was completely covered by oil. After 5 days the oil on the surface had dissipated but was concentrated along the bank, on the mud and on the marsh plants. On day 1 after the spill the oil concentration was shown by gas chromatographic analysis of pond water to be 33 mg/liter, but this quickly dissipated to about 1.5 mg/liter after 2 weeks. Primary production in the phytoplankton community 2 weeks after the spill occurred revealed a 44 to 65% reduction and 30-50% reduction in respiration. Two months after the spill, primary productivity and respiration in the oiled pond were only 17% and 7% lower, respectively, than in the control pond. In the experimental impoundments at a concentration of 0.2 mg Arabian Empire Mix and Nigerian oil per liter of water in situ radiocarbon uptake by phytoplankton was lower than that of the control pond. One or two months later primary productivity was significantly higher in the Nigerian and Arabian oil ponds than in control and Empire Mix ponds. The changes in plankton metabolism in both natural ponds and impoundments were evaluated on the basis of data simultaneously obtained from adjoining control ponds. (Baker-FRC)
W84-00151

IMPACT OF POLLUTION ON ZOOPLANKTON COMMUNITIES IN THE MARSEILLES DOMESTIC SEWAGE DISCHARGE ZONE. (IMPACT DE LA POLLUTION SUR LES COMMUNAUTES ZOOPLANCTONIQUES DANS LA ZONE D'EPANDAGE DE L'EMISSAIRE URBAIN DE MARSEILLE),
Centre Univ. de Luminy, Marseille (France). Lab. d'Hydrobiologie Marine.
G. Champalbert, and G. Patriti.
Hydrobiologia, Vol 89, No 1, p 17-27, April, 1982. 10 Fig, 1 Tab, 19 Ref.

Descriptors: *Water pollution effects, *Wastewater outfall, *Zooplankton, Municipal wastewater, Population density, Aquatic populations, Marseilles, *France, Mediterranean Sea.

Marseilles, France, discharges domestic wastewater into the Mediterranean Sea. Zooplankton populations have been studied in the polluted area situated near the sewage outlet. Samples were collected along a transect following the course of a float cast off close to the outlet. Three zones, corresponding to decreasing pollution, appeared in the zooplankton populations. In the first zone, which was the most polluted zone and extended for about 500 meters from the outlet, a few tolerant species were abundant, including Acartia clausi, Oithona helgolandica, and Oikopleura sp. In the intermediate zone, which extended for a few kilometers, the densitites of some of the less tolerant species increased, including Paracalanus parvus, Clausocalanus sp., Centropages typicus, Oncaeidae, and Corycaeidae. A third zone, extending for

several kilometers, which may be subject to partial pollution due to residual polluted patches of water, contained tyically neritic populations. (Author's abstract)
W84-00157

AN ASSESSMENT OF MARINE POLLUTION IN PUGET SOUND,
National Oceanic and Atmospheric Administration, Seattle, WA. Office of Marine Pollution Assessment.
For primary bibliographic entry see Field 5B.
W84-00159

THE EFFECTS OF LOW LEVEL TURBIDITY ON FISH AND THEIR HABITAT,
North Carolina State Univ. at Raleigh. Dept. of Zoology.
J. P. Reed, J. M. Miller, D. F. Pence, and B. Schaich.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113646, Price codes: A04 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute Report No 190, August 1983. 50 p, 8 Fig, 6 Tab, 48 Ref. OWRT B-132-NC(1), 14-34-0001-0237.

Descriptors: *Turbidity, *Fish populations, *Aquatic habitats, Ponds, *Water temperature, Water depth, Dissolved oxygen, *Suspended solids, Suspended sediments, *Light penetration, Aquatic plants, Plant populations, Chara, *Cyanophyta, Submerged plants, Fish food organisms, Productivity, Primary productivity, Chlorophyll A, Epilimnion, Secchi disks, Mathematical models, North Carolina, Raleigh.

The effects of low level turbidity on fish habitat were investigated in a pond near Raleigh, NC. Three levels of turbidity were maintained in polyvinylchloride curtain enclosures with open bottoms each of which enclosed 260-400 m super 2 and had a maximum depth of 2 m. Turbidity levels in the pond routinely ranged from 6 to 50 NTU turbidity units with peaks associated with blue-green algal blooms in excess of 120 NTU. Total suspended solids, TSS, explained 68% of the variability associated with turbidity: a 10 mg/1 increase in TSS increased turbidity 6 NTU units. Turbidity directly affected light penetration. As light penetration decreases, the light energy is transformed into heat over a shorter distance and higher epilimnetic temperatures may result. The magnitude of the temperature change increases as the turbidity increases and/or depth of the epilimnion decreases. For an epilimnion depth of 0.25 m, temperatures in the turbid enclosure (28 NTU) were 2-5C higher than the cleared enclosure (14 NTU). However, at the 'normal' epilimnion depth of 1 m, large increases in turbidity resulted in only small temperature increases. Turbidity also had an effect on submerged macrophytes. A reduction from 12 NTU to 6 NTU enabled them, due to the increased available light, to colonize deeper waters. This increase in plant biomass would result in increased invertebrate prey and therefore higher fish production.
W84-00162

EUTROPHY IN LAKE ACULEO, CHILE,
Chile Univ., Santiago. Dept. of Cell Biology and Genetics
S. S. Cabrera, and V. B. Montecino.
Plant and Soil, Vol 67, No 1-3, p 377-387, 1982. 3 Fig, 7 Tab, 12 Ref.

Descriptors: *Eutrophication, *Lakes, *Productivity, Eutrophic lakes, Lake Aculeo, *Chile, Water pollution effects, Nutrients, Nitrogen, Carbon cycle, Primary productivity, Chlorophyll a, Phytoplankton, Algae.

Nitrogen turnover was studied in Lake Aculeo, near Santiago, Chile, a highly eutrophic body of 7 m maximum depth, 4.4 m mean depth, and 5.8 km length. Concentrations of chlorophyll a varied from 487 mg per cu m at 0.6 m depth in January 1981 to 28.4 mg per cu m at 1.0 m depth in September 1980. Primary productivity fluctuated between 578 + or - 24.8 mg C per cu m per hour on the surface in November 1978 to 3.8 + or - 0.9 mg C per cu m per hour at 2.5 m depth in November 1980. Carbon fixation varied from 157,000 kg C per month in June to 1.34 million kg C per month in December for a yearly total of 6.25 million kg C. Nitrogen turnover, based on a C:N ratio of 6:1, was 1.04 million kg N per year. Nutrients from untreated wastewater and agricultural runoff contribute to the eutrophic condition. (Cassar-FRC)
W84-00172

EFFECTS OF TEMPERATURE AND COLOR COMPONENTS OF WASTEWATER DISCHARGES ON AQUATIC COMMUNITIES,
Westvaco Corp., Covington, VA.
T. G. Botkins, Jr.
Tappi Journal, Vol 66, No 3, p 107-110, March, 1983. 4 Fig, 2 Tab.

Descriptors: *Wastewater disposal, *Water pollution effects, *Pulp and paper industry, Industrial wastes, Aquatic life, Fish, Thermal pollution, Effluents, Bioassays, *Virginia, Jackson River.

A thermal discharge demonstration study was conducted to evaluate the effects of temperature and color components of Westvaco's bleached kraft and semi-chemical pulp and paper mill discharges on aquatic communities in the Jackson River. The study included the development of a longitudinal, time-dependent, thermo-hydraulic model to simulate river flows and temperatures after the dam becomes operational, which is being constructed to reduce the extremes of high and low flow of the Jackson River; an evaluation of the thermal tolerance limits of representative, important species of fish and supportive trophic levels relative to anticipated elevations in river temperatures downstream of the mill; and the execution of temperature/color bioassays to assess the joint effect of these factors on a locally important game fish. It was concluded that the discharge of heat and color by the continued operation of the mill will not cause an imbalance of the indigenous aquatic communities in the Jackson River below the mill. (Baker-FRC)
W84-00177

HEALTH STATUS OF THE POPULATION IN RELATION TO THE USE OF SLIGHTLY MINERALIZED SOFT DRINKING WATER (SOSTOYANIE ZDOROV'YA NASELENIYA V SVYAZI S ISPOL'ZOVANIEM MYAGKIKH MALOMINERALIZOVANNIKH VOD DLYA PIT'YA),
Nauchno-Issledovatel'skii Inst. Gigieny, Moscow (USSR).
Yu. V. Novikov, S. I. Plitman, A. I. Levin, N. U. Shniger, and T. N. Yershova.
Gigiena i Sanitariia, No 12, p 3-6, December, 1980. 3 Tab, 10 Ref.

Descriptors: *Drinking water, *Toxicity, *Water quality standards, Water softening, Minerals, Calcium, Trace metals, Public health.

Morbidity rates and the results of medical examinations were analyzed and a questionnaire survey was conducted in an effort to assess the health status of the population of a Far Eastern region of the USSR where the drinking water is the slightly mineralized soft water characteristic of the Far East. This water is low in minerals (50 to 70 milligrams per liter), has a low hardness (0.8 to 2.0 milligrams-equivalent per liter), has low levels of calcium (2 to 15 milligrams per liter) and magnesium (2 to 10 milligrams per liter), and is deficient in fluorine (0.2 to 0.3 milligrams per liter), while containing lead, arsenic, cobalt, silver, and molybdenum ions. It has been determined that the water has selective actions on the gastrointestinal tract, urinary organs, bony tissue, and the cardiovascular system, and that diseases of the endocrine and nervous systems and of sense organs are more prevalent in the region under study than elsewhere in USSR. The results of these studies have been confirmed and supplemented by the results of a toxicologic experiment on white rats. White rats given the same water had a skin with reduced bactericidal activity and showed a tendency to impaired lipid and mineral metabolism and thyroid hyperfunction. These findings may be of value in predicting the health status of a community and in developing remedial and preventive measures. They may also serve as criteria in establishing revised hygienic standards for drinking water. (Author's abstract)
W84-00293

ON HYGIENIC STANDARDS FOR COPPER IN DRINKING WATER (K NORMIROVANIYU MEDI V PIT'EVOI VODE),
Institut Gigieny Truda i Profzabolevanii, Sverdlovsk (USSR).
V. G. Nadeenko, E. A. Borzunova, K. P. Selyankina, V. G. Lenchenko, and N. N. Petrova.
Gigiena i Sanitariia, No 3, p 8-10, March, 1980. 2 Tab, 1 Ref.

Descriptors: *Drinking water, *Copper, *Water quality standards, Heavy metals, Toxicity, Embryonic growth stage, Public health.

When ingested in drinking water where it is present at the level of the existing maximum allowable concentration, copper has an adverse effect on pregnancy. Embryotoxic effects of copper are manifested in high embryonal mortality and impairment of ossification processes. It is suggested that the metal may have a toxic action on the fetus through the maternal organism. The embryotoxic effects are believed to result from alterations caused by copper in the metabolic processes in sex cells and in biotransformation of trace elements in the placenta and fetus. It is recommended that the maximum allowable concentration for copper in drinking water be set at a lower level of 0.1 milligrams per liter on the basis of these toxicological effects. (Author's abstract)
W84-00294

RESULTS OF TOXIC ACTION OF WATER POLLUTANTS ON DAPHNIA MAGNA STRAUS TESTED BY AN IMPROVED STANDARDIZED PROCEDURE (ERGEBNISSE DER SCHADWIRKUNG WASSERGEFAHRDENDER STOFFE GEGEN DAPHNIA MAGNA IN EINEM WEITERENTWICKELTEN STANDARDISIERTEN TESTVERFAHREN),
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 7B.
W84-00325

FACTEURS RESPONSABLES DE LA DISTRIBUTION DES GASTEROPODES DULCICOLES DANS LE FLEUVE SAINT-LAURENT (FACTORS GOVERNING THE DISTRIBUTION OF FRESHWATER GASTROPODS IN THE ST. LAWRENCE),
Quebec Univ., Montreal. Centre de Recherche en Sciences de l'Environnement.
A. Lamarche, P. Legendre, and A. Chodorowski.
Hydrobiologia, Vol 89, No 1, p 61-76, April, 1982. 5 Fig, 5 Tab, 36 Ref.

Descriptors: *Water quality, *Water pollution effects, *Benthos, Snails, Saint Lawrence River, Hydrocarbons, Organic compounds, Prosobranchs, Pulmonates, Vegetation.

Freshwater gastropod samples were taken from the Saint Lawrence River near Montreal. The samples were studied in an attempt to characterize the populations living in the benthos and on the vegetation, and in order to define the effects of deteriorating water quality on the aquatic life. A total of 98 samples were collected simultaneously from benthos and macrophytes; populations were expressed as the log of each species' relative abundance. Clustering, principal coordinates and discriminant analyses were used to describe and characterize differences between samples. Diversity was also computed to show the transformations of population structure due to differences in pollution levels. Benthic populations were dominated by prosobranch snails, while pulmonates characterized the vegetation inhabitants. The number of species decreased in response to increasing pollution levels on both types of substrates. High hydrocarbon levels were related to a decrease in the

diversity of snail populations on the vegetation only. A differential dependence of prosobranchs in the benthos and of epiphytic pulmonates on the aquatic medium explains the predominance of each species of snails on each substrate. Modes of nutrition were significant factors. Sporadic oil spills affected the snail populations living on macrophytes. (Baker-FRC)
W84-00339

5D. Waste Treatment Processes

THE APPLICATION OF KAOLIN FOR CONTROL OF HEAVY METALS IN ANAEROBIC SLUDGE DIGESTION,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
W. H. Cross, and P. M. Rossello.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110766, Price codes: A04 in paper copy, A01 in microfiche. Environmental Resources Center Report No ERC 11-83, Georgia Inst. of Technology, Atlanta, August 1983. 43 p, 2 Tab, 16 Fig, 23 Ref. OWRT A-092-GA(1), 14-34-0001-1111.

Descriptors: *Anaerobic digestion, *Heavy metals, *Isotherms, Kaolin, *Kaolinite, *Wastewater treatment, Nickel, Copper, Chromium, Zinc.

Six laboratory-scale anaerobic digesters were used to evaluate the potential of kaolin addition for the control of heavy metal toxicity. Adsorption isotherms were obtained for the kaolin-metal system in solutions of the individual metals, nickel, copper, chromium and zinc and in mixtures of the metals. The adsorption-ion exchange capacity of kaolin for the metals decreased in the order Cr(III) > Cu > Ni > ZN. The performance of digesters containing kaolin only, metals only and kaolin and metals was compared to that of a control to which no metals or kaolin were added. The sludge used was obtained from a local secondary activated sludge sewage treatment plant. Kaolin was fed at a concentration of 1,00 mg/l and the metals content in the feed were increased in every digester and throughout the digesters. The addition of kaolin did not have effect on performance in the non-metals fed digester as compared to the control. However, the presence of kaolin in the metals fed digesters appeared to afford a means of minimizing inhibition by the heavy-metals. The kaolin fed digesters became acclimated to slightly higher concentrations of metals than the non-kaolin fed unit and performed nearly as well as the non-metals fed digesters.
W84-00003

FEASIBILITY AND EFFECTS OF WATER QUALITY ON BAIT-FISH CULTURE IN AERATED SEWAGE TREATMENT LAGOONS IN VERMONT,
Vermont Univ., Burlington.
For primary bibliographic entry see Field 5C.
W84-00006

PROPERTIES AND LONG-TERM BEHAVIOR OF ION EXCHANGE MEMBRANES,
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie.
For primary bibliographic entry see Field 3A.
W84-00059

ULTRAFILTRATION PROCESSES FOR POLLUTION CONTROL AND CHEMICAL REUSE IN THE TANNING INDUSTRY,
Naples Univ. (Italy). Facolta di Ingegneria.
For primary bibliographic entry see Field 3A.
W84-00062

ELECTRODIALYSIS IN THE REGENERATION OF PAPER MILL SPENT LIQUOR,
Indian Inst. of Tech., Bombay. Dept. of Chemical Engineering.
K. Radhamohan, and S. Basu.
Desalination, Vol 33, No 2, p 185-200, May, 1980. 12 Fig, 21 Ref.

Descriptors: Desalination, Desalination processes, Regeneration, Environmental pollution abatement, *Electrodialysis, Product recovery, Electromembrane process, Soda, Lignin, Black liquor.

Experiments have been carried out on the electrodialytic regeneration of soda and lignin from alkaline black liquor with the abatement of environmental pollution for a smaller capacity rice straw-based pulping plant. To predict the performance capability of the system, the hydrodynamic characteristics of a multi-compartment electrodialysis cell have been correlated with the polarizing parameters in three simplified equations. For efficient and economical recovery of soda along with lignin, a two stage electromembrane process, consisting of conventional ED with a -C-N-C-N-C arrangement, followed by an electrogravitational technique is recommended.
W84-00066

BOD REMOVAL EFFICIENCIES IN TWO STABILIZATION LAGOONS IN SERIES IN MALAYSIA,
Engineering-Science, Inc., Arcadia, CA.
R. M. Bradley.
Water Pollution Control, Vol 82, No 1, p 114-122, January, 1983. 5 Fig, 1 Tab, 26 Ref.

Descriptors: *Lagoons, *Wastewater lagoons, *Biological oxygen demand, Wastewater treatment, Stabilization lagoons, Wardieburn, *Malaysia.

Average BOD removal efficiencies in the stabilization lagoon system in Wardieburn, Malaysia, averaged 79% from 1975 to 1980; suspended solids removal efficiencies averaged 50%. This two-lagoon system, about 1 ha in total area and 1.4 m operating depth, was designed to serve 8000 people. The BOD effluent standard of 50 mg per liter as attained in all but one year. BOD removal in the primary lagoon was 62-70%; in the secondary lagoon, 26-49%. Fluctuations in suspended solids removal, 26-52% in the primary lagoon and 1-31% in the secondary lagoon, were attributed to algal growth. Algal biomass contributed about 11% of the BOD in the primary lagoon effluent and 50-60% of the BOD in the secondary effluent. This lagoon was classified as facultative for most of the time. Although the surface aerobic layer is thin on occasion, the lagoon is not anaerobic. However, the current BOD loading on the primary lagoon is approaching the maximum level recommended for a facultative lagoon at 29C. Equations are given for calculating a real BOD removal from the primary lagoon, secondary lagoon, and the two lagoons in series. Maximum BOD removal efficiency can be achieved by having a larger surface area on the primary lagoon than on the secondary lagoon, thus maximizing the BOD load on each lagoon. (Cassar-FRC)
W84-00091

MEASUREMENT OF THE PERFORMANCE OF SEWERAGE SYSTEMS AND ASSOCIATED HYDRAULIC STRUCTURES--RECENT DEVELOPMENTS,
Severn-Trent Water Authority (England). Avon Div.
A. J. Baughen, and A. R. Eadon.
Water Pollution Control, Vol 82, No 1, p 77-86, January, 1983.

Descriptors: *Sewer systems, *Flow measurement, *Performance evaluation, Monitoring, Gages, Measuring instruments, *Wastewater treatment.

Monitoring devices for sewage systems are described. Flow measurement is possible with hydraulic devices (flumes, notches, and weirs), chemical dilution tests, velocity and depth measurements, and electromagnetic gages. Sewage level can be measured by many types of gages, ultrasonic gages being especially in favor. Pumping rates may be monitored by calculation from hours run and the design curves, magnetic flowmeters, ultrasonic gages, and Doppler meters. It is also important to monitor ancillary information such as river levels, water table levels, and soil moisture deficit. Instrumentation in use at the Avon Division, Severn-Trent Water Authority, is described. Doppler meters, Arkon bubblers, ultrasonic gages, fiberglass flumes, the Manning Dipper, and level recorders are examples. Future developments include 6-channel recorders, rolling barrel information storage, and computer storage of information. (Cassar-FRC)
W84-00092

THE USE OF PERFORMANCE INDICATORS IN SEWAGE TREATMENT APPRAISAL,
Yorkshire Water Authority (England). Southern Div.
H. B. Tench.
Water Pollution Control, Vol 82, No 1, p 61-76, January, 1983. 7 Fig, 8 Tab.

Descriptors: *Performance evaluation, *Costs, *Wastewater treatment, Yorkshire Water Authority, Operating costs, *England.

The Yorkshire Water Authority developed performance indicators for use in its wastewater treatment plants. These are divided into resource utilization indicators (financial costs, physical parameters, trade effluent, and comparison of population costs), intended to provide information on the cost structures, and works performance indicators (COD removal, etc.), to give information on the standard of service supplied. An evaluation for three areas in the Southern Division of the Yorkshire Water Authority showed that from 1978-79 to 1979-80 operating costs rose by 39% while inflation for resources used rose by 47%. Use of indicators clearly reflected the Rother area's commissioning of a new works, the relatively high operating costs of filter pressing and incineration of sludge combined with a decrease in volume of trade effluent in the Don area, and the low operating costs at Dearne, which uses percolating filters and disposal of liquid sludge to land. (Cassar-FRC)
W84-00093

SOLVING A DIFFICULT SEWER REHABILITATION PROBLEM,
Park Ridge City Engineer's Office, IL.
J. H. Utz.
Public Works, Vol 114, No 3, p 59-60, March, 1983.

Descriptors: *Sewer systems, *Liners, *Rehabilitation, Pipes, Excavation, Environmental effects, *Illinois, Park Ridge.

A badly deteriorated sewer, 21 inches in diameter and 371 ft long, was located under 5 large, healthy elm trees in a residential section of Park Ridge, Illinois. To avoid damage to the trees by conventional excavation, the sewer was rehabilitated with a polyester felt liner impregnated with a liquid thermosetting resin. The liner was installed with an inversion tube and water pressure, which turned the liner inside out and forced it into the pipe. When the liner was in place, the water was heated and recirculated to harden the resin. Installation and curing of the liner took 15 hours. Service to all affected individual homes was restored within 36 hours of starting the installation. Although some excavation was necessary to repair two small sections of sewer and to connect-disconnect some of the service lines, trees and paving were not greatly disturbed. (Cassar-FRC)
W84-00118

TREATMENT PLANT HAS PARK-LIKE SETTING,
Burgess and Niple Ltd., Columbus, OH.
P. M. Shepard, Jr.
Public Works, Vol 114, No 3, p 75-76, March, 1983.

Descriptors: *Parks, *Aesthetics, *Landscaping, Wastewater treatment facilities, Delaware County, *Ohio, Olentangy Environmental Center.

The Olentangy Environmental Control Center, as the new Delaware County, Ohio, wastewater treatment plant is called, was designed to masquerade as a park to avoid detracting from the Highbanks Metro Park across the river. The planners

took special care to minimize noise and odor. The plant contains lawns, extensive landscaping, buildings with cedar siding and shaked roofs, pergola-covered walkways, gazebos, ponds, a split rail fence, and a 20 ft fountain. Aeration tanks, aerobic digesters, and clarifiers are below ground level. About $1.5 million was spent for the esthetic improvements. (Cassar-FRC)
W84-00119

LAND APPLICATION: A NEW APPROACH TO PLANT EFFLUENT TREATMENT,
Law Engineering Testing Co., Marietta, GA.
G. L. Taylor, L. A. Neal, and N. Dee.
Pulp and Paper, Vol 57, No 3, p 81-84, March, 1983. 3 Fig, 9 Ref.

Descriptors: *Pulp and paper industry, *Land application, *Industrial wastewater, Pulp wastes, *Wastewater treatment, Wastewater irrigation, Irrigation, Color removal, Spray irrigation, Lagoons, Wastewater lagoons.

Land treatment of pulp and paper mill effluents is an alternative to traditional methods of waste treatment. Among the advantages of land treatment are elimination of the need for locating new mills on rivers and reduction of waste discharge into rivers. Effluents currently being treated in this manner are sulfite, kraft, groundwood, strawboard, hardboard and insulation, boxboard and paperboard, deinking, and recycling plant types. Four major techniques of waste application, which may also be combined to fit a particular site, are rapid infiltration in a series of shallow lagoons, overland flow (usually down a 2-4% slope), spray irrigation (the most versatile), and soil incorporation (shallow injection or plowing of wastes into soil). Calculation of the assimilative capacity of a site is difficult and depends on many factors, including the soil and groundwater properties. Land treatment is particularly effective for reducing color in effluents. Lignin, which is responsible for most of the color in pulp mill effluents, is readily degraded by soil microbes. (Cassar-FRC)
W84-00122

A PILOT-SCALE PERCOLATING FILTER FOR USE IN SEWAGE TREATMENT STUDIES,
Trinity Coll., Dublin (Ireland).
N. F. Gray, and M. A. Learner.
Water Research, Vol 17, No 3, p 249-253, March, 1983. 5 Fig, 14 Ref.

Descriptors: *Pilot plants, *Filters, *Wastewater treatment plants, Sampling, Monitoring, Percolating filters.

A pilot-scale percolating filter, easily constructed from materials available in a storeroom or at a sewage works site, is described. It consists of three stacked reinforced concrete manhole sections supported on a concrete block-reinforced concrete base. The medium is supported on a steel grid resting inside the concrete blocks. Sampling and monitoring facilities are built in. This apparatus is easily modified, versatile, low in cost, and adaptable in a wide range of research, evaluation, and development work. (Cassar-FRC)
W84-00123

SIMULTANEOUS ELECTROFLOTATION AND DISINFECTION OF SEWAGE (ELECTROFLOTTATION ET DESINFECTION SIMULTANEE D'EAUX RESIDUAIRES URBAINES),
Electricite de France, Chatou. Direction des Etudes et Recherches.
P. Costaz, J. Miquel, and M. Reinbold.
Water Research, Vol 17, No 3, p 255-262, March, 1983. 9 Fig, 5 Tab, 9 Ref.

Descriptors: *Disinfection, *Oxidation, *Chlorination, Flotation, Electroflotation, *Wastewater treatment, Wastewater oxidation, Flocculation, Activated sludge process.

Simultaneous electroflotation and disinfection of wastewater was studied on the pilot-plant scale. Chlorine and oxygen were generated from chloride ion, the amount depending on current density (100, 200, and 300 A per sq m), COD, chloride concentration (300 to 3000 mg per liter), and oxidation potential of the effluent. Effluent had been pretreated with ferric chloride and an organic polymer. Solid-liquid separation was improved compared to that achieved by static clarification for 2 hours, and the disinfection efficiency was equal to or better than that obtained with gaseous chlorine. For example, at a 900 mg per liter chloride concentration and the three current densities tested, a quantity of 47 million coliforms per 100 ml in the effluent was reduced to 0-1400 per 100 ml. The process produced highly concentrated sludges, suitable for recycling in the activated sludge process. (Cassar-FRC)
W84-00125

EFFECT OF TEMPERATURE AND PH VALUE ON THE GROWTH-RATE CONSTANTS OF NITRIFYING BACTERIA IN THE ACTIVATED SLUDGE PROCESS,
Water Research Centre, Stevenage (England).
H. A. Painter, and J. E. Loveless.
Water Research, Vol 17, No 3, p 237-248, March, 1983. 5 Fig, 6 Tab, 14 Ref.

Descriptors: *Nitrification, *Activated sludge process, *Kinetics, Bacteria, *Wastewater treatment, Temperature effects, Hydrogen ion concentration, Growth rates.

The specific growth rates of nitrifying bacteria were determined under nonequilibrium conditions in a laboratory-scale activated sludge plant at three temperatures (16, 20, and 25C) and over a pH range of 6.0 to 8.5. Generally, nitrification began soon after the beginning of the experiment. However, no nitrification occurred at pH 6.0. For most experiments a pH range of 7.5-8.0 was optimum, with a gradual decrease in rate constant on each side of optimum. There was no apparent pattern in the effects of temperature on nitrification. Undiluted and stale sewage produced higher doubling times than dilute sewage. The reason for this was probably a lower concentration of toxic, inhibitory substances in the dilute sewage. The onset of nitrification was more positive with diluted sewage than with stale or undiluted sewage. Addition of ammonium carbonate lowered doubling times slightly. Growth rate constants at 20C, pH 7.5, were 0.10-0.42 per day for Nitrosomonas in activated sludge grown on domestic sewage. In about half the cases the rate constant for Nitrosomonas was greater than that for Nitrobacter. (Cassar-FRC)
W84-00126

HOW THE ROCKY MOUNTAIN ARSENAL IS HANDLING GROUNDWATER CONTAMINATION,
Rubel and Hager, Inc., Tucson, AZ.
D. B. Hager, and C. G. Loven.
Water/Engineering and Management, Vol 130, No 3, p 18-19, March, 1983. 1 Tab.

Descriptors: *Groundwater pollution, *Chemical wastes, *Activated carbon, Adsorption, Rocky Mountain Arsenal, Denver, *Colorado, Water pollution control, Injection welis, Organic compounds, *Wastewater treatment.

Groundwater contaminated with inorganic and organic chemical wastes from the operations at the Rocky Mountain Arsenal, Colorado, has been contained by slurry wall and hydraulic barriers and by treatment of water with a counter-current granular activated carbon adsorption system. Several dewatering and reinjection wells were installed as part of the activated carbon system. Diisomethylphosphonate was found in highest concentrations, maximum 1130 micrograms per liter. Other chemicals of particular concern were dicyclopentadiene, dibromodichloropropane, and pesticides. Monitoring of treated water quality during 1982 indicated that levels of these chemicals in treated effluents were below detection limits. (Cassar-FRC)
W84-00133

FACTORS INFLUENCING BIOFOULING OF REVERSE OSMOSIS MEMBRANES AT WATER FACTORY 21: CHEMICAL, MICROBIOLOGICAL AND ULTRASTRUCTURAL CHARACTERIZATION OF THE FOULING LAYER (VOLUME III-B),
Orange County Water District, Fountain Valley, CA.
H. F. Ridgway, D. G. Argo, and B. H. Olson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113570, Price codes: A06 in paper copy, A01 in microfiche. Final Report, November 1981. 113 p, 30 Fig, 11 Tab, 50 Ref. OWRT C-80159-R(5)(8520).

Descriptors: *Advanced wastewater treatment, *Wastewater renovation, *Water reuse, Reverse osmosis, Microbial fouling, Biofilm composition, Fouling bacteria, California, Water Factory 21, Orange County Water District.

Biofouling of cellulose diacetate reverse osmosis (RO) membranes used for dimineralization of municipal wastewater was investigated at Water Factory 21, a 0.66 m3/sec (15mgd) advanced wastewater reclamation facility located in Fountain Valley, California. The fouling material was primarily organic in composition (at 90% dry wt) and contained 13% to 18% carbohydrate and 15% to 30% protein. The principal inorganic elements detected were chlorine, calcium, phosphorus and sulfur. Electron microscopy revealed that the fouling bacteria were attached within the biofilm via a network of extracellular polymeric fibrils. Substantial concentrations of adenosine 5'-triphosphate were detected in the biofilm, indicating that the fouling bacteria were metabolically active and potentially able to grow and multiply in situ. In addition, the attached fouling bacteria actively accumulated (3H) glucose and were able to reduce p-iodonitrotetrazolium violet dye (INT) to the insoluble INT-formazan complex. Plate counts indicated 4x10 to the fifth power to 5x10 to the sixth power bacteria per cm squared on the feedwater surface of the RO membranes. Presominant genera associated with the feedwater and permeate water surfaces of the RO membranes were identified. Predominant genera associated with the same or related microbial genera were detected in the feedwater supplying the RO facility. Although there was some correlation between the physico-chemical and microbiological properties of the RO feedwater and the membrane fouling layer, the dynamics of this interaction were not investigated.
W84-00135

EVALUATION OF MEMBRANE PROCESSES AND THEIR ROLE IN WASTEWATER RECLAMATION: VOLUME III-A,
Orange County Water District, Fountain Valley, CA.
D. G. Argo, and M. G. Rigby.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113588, Price codes: A14 in paper copy, A01 in microfiche. Final Report, November 1981. 252 p, 68 Fig, 78 Tab, 12 Ref, 1 Append. OWRT C-80159-R(8520)(4).

Descriptors: *Advanced wastewater treatment, *Wastewater renovation, *Water reuse, Reverse osmosis, Electrodialysis, Ultrafiltration, Biofilm development, Fouling, Costs, *California, Water Factory 21, Orange County Water District.

Water Factory 21 (WF-21) in Orange County, California, is a 15-mdg advanced wastewater treatment (AWT) plant designed to reclaim biologically treated municipal wastewater for injection into a seawater barrier system. Processes included are lime treatment, air stripping, filtration, activated carbon adsorption, reverse osmosis (RO), and chlorination. This report presents operating data from WF-21 collected during the final year of a three-year project. The effectiveness of each treatment process is presented including RO dimineralization, ultrafiltration, and electrodialysis. The data collected show that the combined processes, including RO, used at WF-21 are capable of producing a very high quality water on a reliable basis. Treatment reduced all contaminants, to levels below national interim primary drinking water regulation maximum contaminant levels. It was found that lime clarified secondary effluent can be used

as feedwater to a RO dimineralizer. This lime/RO process substantially reduces the pretreatment requirements and cost of reclamation. Experiments with new low pressure membranes (250 psi) show great potential for reducing RO costs. The major cost of RO flux decline was formation of an active biofilm on the membrane surface. The cost of AWT at WF-21 is $1,140 per million gallons. The cost of RO demineralization is $836 per million gallons. These costs include all operation and maintenance as well as amortization of capital. W84-00136

ABATEMENT OF HEAVY METALS IN INDUSTRIAL EFFLUENTS BY A CATALYZED, ELECTROCHEMICAL REMOVAL SCHEME,
North Carolina State Univ. at Raleigh. Dept. of Chemical Engineering.
J. L. Ayres, and P. S. Fedkiw.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113638, Price codes: A04 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute Report No 207, August 1983. 71 p, 12 Fig, 6 Tab, 41 Ref. OWRT A-133-NC(1), 14-34-0001-2135.

Descriptors: Water pollution control, *Heavy metals, Water pollution treatment, Electrochemistry, *Industrial wastewater, *Ion-selective electrodes, *Wastewater treatment, Copper, Lead, Iron, Zinc, Nickel.

This report represents the work performed in the first year of a two-year project. An evaluation of lead and copper deposited on a reticulated vitreous carbon (RVC) surface as a catalytic agent for the electrodeposition of Cu(II), Ni(II), Pb(II), and Zn(II) from dilute solutions (10 mg/1) was performed using a flow-through porous electrode reactor. Copper showed a very strong catalytic activity for Zn(II) and Ni(II) electrodeposition at loadings from 20 to 50 ug/cm super 2. The removal efficiency of Cu(II) from a 100 mg/1 solution circulated from a reservoir to a porous, flow-by, uncatalyzed electrode and back to the reservoir was examined. A current efficiency of 87% was measured as the concentration of Cu(II) was lowered from 95.6 ppm to 0.05 ppm. An electrical operating cost of 11 cents per lb. of copper recovered can be estimated from the results. This should be compared to the cost of chemicals required if precipitation is used of 65.3 cents per lb. of copper removed. In addition, the volume of waste generated is considerably lower in the electrolytic route in comparison to precipitation; the volume of precipitation-generated sludge composed of 4% solids is 4.45 gal per lb. of copper as compared to .0279 gal per lb. copper (50 percent of void volume in RVC filled by copper) electrochemically generated.
W84-00161

ANAEROBIC FLUIDIZED BED EXPERIMENTATION WITH A MOLASSES WASTEWATER,
Aktiebolaget Sorigona, Staffanstorp (Sweden).
B. Frostell.
Process Biochemistry, Vol 17, No 6, p 37-40, November/December, 1982. 2 Fig, 3 Tab, 11 Ref.

Descriptors: *Anaerobic conditions, *Fluidized beds, *Biological wastewater treatment, *Wastewater treatment, Sand, Industrial wastewater.

A beet molasses wastewater from a baker's yeast factory (COD, 9.1 kg per cu m) was treated in a laboratory scale anaerobic fluidized bed using a sand carrier and external solids recycling. After design changes, stable treatment at 20-25 kg COD was attained. At a loading rate of 22.2 kg COD per cu m per day methane conversion was 43%. Maximum biomass concentration was 22 kg VS per cu m, of which only 13 kg VS per cu m was attached. By the end of the 165-day experiment the solids retention time was 11-13 days. The system tolerated high suspended solids concentrations--average, 11.6 and maximum, 14.0 kg MLTSS per cu m. Startup time necessary to achieve a load of 20 kg COD per cu m per day was long, over 3 months. (Cassar-FRC)
W84-00173

THREE COST EFFECTIVE I/I PROGRAMS.
Public Works, Vol 114, No 1, p 56-57, January, 1983.

Descriptors: *Sewer systems, *Rehabilitation, *Sewer infiltration, Leakage, Grouting, Inspection, Costs, Infiltration, New Jersey, West Virginia, Kansas.

Television inspection and chemical grouting helped three cities to substantially reduce sewer system infiltration/inflow (I/I). Hamilton Township, New Jersey, used a relatively inexpensive TV inspection and sealing unit, which eliminated 90-95% of infiltration and dropped the wastewater flow from 12 to 7 mgd. Not only was the proposed emergency expansion of the treatment plant cancelled, but half of the 16.5 mgd plant was shut down. The inspection unit is also used to view newly built sewer lines before acceptance. In Newport News, Virginia, the I/I was 573% of the actual sewage. TV inspection and smoke testing units, joint sealing chemicals, and associated equipment is being used in a four-year in-house rehabilitation program. Wichita, Kansas, has been running a TV-assisted I/I control program for 12 years. It uses a grout pumping system that can handle a variety of grouts. Although no records of actual I/I reduction have been kept, 53,000 leaking joints have been identified and repaired during the last 9 years. (Cassar-FRC)
W84-00174

THE EFFECT OF CHLORINE DIOXIDE SUBSTITUTION ON BLEACHING EFFLUENT TOXICITY AND MUTAGENICITY,
C-I-L, Inc., Mississauga (Ontario). Chemicals Research Lab.
G. P. Donnini.
Pulp and Paper Canada, Vol 84, No 3, p 74-78, 80, 1983. 4 Fig, 6 Tab, 38 Ref.

Descriptors: *Chlorine dioxide, *Pulp and paper industry, *Bleaching agents, Wastewater effluents, Kraft mills, Pulp wastes, Mills, Toxicity, Daphnia, Chlorination, Mutagenicity, Wastewater treatment.

Kraft pulps were bleached with various levels of chlorine dioxide substitution in the chlorination stage, and the toxicity and/or mutagenicity of the resulting C and El filtrates, as well as of some combined CED and CEDED effluents, were determined. Low levels (4 and 10%) of chlorine dioxide substitution provided significant reductions in the total Daphnia toxicity of C+El filtrates. High levels of substitution provide additional, but proportionally smaller, decreases in toxicity. The mode of chemical addition and the amount of chemicals applied can effect the toxicity substantially . High chlorine dioxide substitution reduces the mutagenicity of chlorination effluents, but sequential chlorination yields higherr activity than simultaneous addition. The toxicity values of combined CED and CEDED effluents from low and high chlorine dioxide substitution are not substantially different. The toxicity values of the respective C and El filtrates do not accurately predict the toxicity of combined effluents. Dl stage filtrates are acutely toxic and could be responsible for a substantial portion of the toxicity of mill acid bleach effluents. In order to compare realistically the toxic load of bleach plant outfall from low and high chlorine dioxide substitution, the toxicity of combined effluents should be measured. (Baker-FRC)
W84-00195

THE APPLICATION OF THIN FILM COMPOSITE MEMBRANES IN PLATE-AND-FRAME SYSTEMS FOR WATER PURIFICATION,
Danske Sukkerfabrikker, Nakskov. Driftteknisk Lab.
W. K. Nielsen, and S. Kristensen.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 383-396, 5 Fig, 3 Tab, 7 Ref. (1st Vol of Proc. of Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Membranes, Water purification, Hyperfiltration, Thin film composite membranes, Plate-and-frame systems, Pulp and paper industry, Food processing industry, Dairy industry, Whey.

Thin film composite membranes are now at such a level where stable and reliable membranes can be produced on a large scale. Utilization of thin film composite membranes within water desalination and in the dairy industry for concentration of whey is outlined. The application for concentrating waste-water streams in the pulp and paper industry is mentioned. The membrane is developed for water desalination. Temperature resistance is 80C for operation. The membrane can stand cleaning with nitric acid, phosphoric acid, caustic soda, and soda ash. Because of a high salt rejection, the rejection of small organic solutes is excellent. This is of importance to waste waters and dairy and food products. Sanitation and cleaning are improved. High temperature operation makes the process possible in new areas and enables capacity increase. Experience is summarized gained with thin film composite membranes in plate-and-frame systems with special regard to: (1) chemical and temperature stability; (2) influence of elevated temperature on organic low molecular weight substances, such as lactic acid and urea; (4) cleaning and sanitation schemes and experience within a number of different applications; and (5) the prospects of thin film composite membranes for water treatment and in the food and dairy industry.
W84-00240

CHEMICAL TREATMENT FOR REUSE OF WASTEWATER EFFLUENTS IN SAUDI ARABIA,
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
H. A. Kharafjian, R. H. Siddiqi, and S. Farooq.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 437-438, 1 Tab (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Water reuse, Wastewater renovation, Reverse osmosis, Lime, Sodium hydroxide, *Desalination, *Wastewater treatment, Dhahran, *Saudi Arabia.

Reclamation of municipal wastewater is receiving increasing attention in Saudi Arabia. In the reclamation process desalination of wastewater becomes necessary when total dissolved solids (TDS) concentration is high. At most locations in Saudi Arabia the TDS of wastewaters ranges between 2000 and 4000 mg/l. A considerable fraction of the dissolved solids is due to salts of divalent cations, magnesium and calcium. Chemical precipitation of these salts would therefore be required as either a single step treatment in the reclamation process or as a preparatory treatment in conjunction with reverse osmosis or electrodialysis. The chemical treatment of raw and biologically treated wastewater at Dhahran was investigated. Lime and sodium hydroxide were used. Both were effective in reduction of TDS and hardness. Some typical preliminary results of treatment of secondary effluent are given.
W84-00246

UTILIZATION OF THE WASTE CONCENTRATED SEAWATER IN THE DESALINATION PLANTS,
Asahi Glass Co. Ltd., Chiba (Japan).
T. Kawahara, and K. Suzuki.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 499-507, 8 Figs, 4 Tab, 2 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Manama, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, *Electrodialysis, Desalination apparatus, Flash evaporator, Salts, Brines, Water reuse, Salt recovery.

Concentration of waste brine exhausted from flash evaporator was studied with a newly developed concentration technique. The results were that concentration of NaCl in concentrated brine, its purity, electric power consumption and its cost,

respectively, were 264(g/l), 96(%) (NaCl/T.salts) and 238(KWH/t-NaCl). Installation cost was 3,380 million yen and total concentrated brine cost including amortization was 2,760 sub 3(Yen/t-NaCl) under the following design basis. Quantity of waste brine 100,000(m super 3/D), production capacity 610,000(t-NaCl/Year), current density 7(A/dm2), electricity 5(Yen/KWH). Installation cost and operating cost for recovery of salt have been substantially reduced, so electrodialytic concentration process appears more attractive than it has hitherto been the case for the industrial use or manufacturing of table salt.
W84-00252

WATER SOFTENING BY DIFFUSION USING CATION EXCHANGE MEMBRANES,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
B. S. Joshi, and K. P. Govindan.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 509-516, 2 Figs, 5Tab, 7 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Manama, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, *Membrane processes, Water treatment, Water softening, Cation-exchange membranes.

Water softening by an interionic diffusion process across a cation-exchange membrane is studied. A twenty compartment laboratory scale unit with an effective cross-sectional area of 63 sq cm is assembled and studied for water softening using an interpolymer cation exchange membrane developed in this institute. Alternate compartments formed by thin gaskets are fed with synthetic hard waters and sodium chloride as regenerant solution in a counter current series flow arrangement. Results on softening of hard water of 500, 1000, 1500 ppm as CaCO3 containing sodium chloride in the ratios: 1:0, 1:1 and 1:2 are given. The regenerant concentrations of 0.5, 1.0 and 1.5 N are studied for softening efficiency. Diffusion of salt and water through the membranes and the effect of regeneration levels to achieve 80% softening is also investigated. The commercial prospects for a continuous softening system by this method are discussed.
W84-00253

DEMINERALIZATION BY ELECTRODIALYSIS USING AMPHOLYTIC ION-CONDUCTING SPACERS,
Central Salt and Marine Chemicals Research Inst., Bhavnagar (India).
K. P. Govindan, and P. K. Narayanan.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 517-527, 1 Fig, 5 Tab, 7 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Manama, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Electrodialysis, Water treatment, Demineralization, Ion-conducting spacers.

The synthesis of ampholytic ion-conducting spacers and their use in demineralization of low saline waters with cost of treatment are given. The various modifications on the use of conducting spacers in demineralization by electrodialysis are discussed. Extension of the technique in prevention of environmental pollution by recovery of valuable materials and elimination of harmful ions in trace quantities is also described.
W84-00254

OPERATION OF A HORIZONTAL TUBE BRINE CONCENTRATOR,
Israel Desalination Engineering Ltd., Tel-Aviv.
For primary bibliographic entry see Field 3A.
W84-00272

EFFECT OF THE ENERGY CRISIS ON WATER DESALINATION AND WASTE WATER RECYCLING BY ION EXCHANGE,
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Div. of Membranes and Ion-Exchangers.
For primary bibliographic entry see Field 3A.
W84-00274

IS MONOD'S APPROACH ADEQUATE FOR THE MODELING OF PURIFICATION PROCESSES USING BIOLOGICAL TREATMENT. (FAUT-IL ABANDONNER LE FORMALISME DE MONOD POUR LA MODELISATION DES PROCESSUS DE DEPOLLUTION PAR VOIE BIOLOGIQUE.),
Institut National des Sciences Appliquees de Lyon, Villeurbanne (France). Lab. de Chimie et Genie de l'Environnement.
H. Roques, S. Yue, S. Saipanich, and B. Capdeville.
Water Research, Vol 16, No 6, p 839-847, June, 1982. 7 Fig, 1 Tab, 25 Ref.

Descriptors: *Biological treatment, *Wastewater treatment, *Mathematical studies, Mathematical models, Anaerobic treatment, Fermentation.

Experimental evidence has demonstrated that it is not possible to use Monod's model to express the velocity of purification processes using biological treatment. This is so because it is impossible to estimate the effects of the substrate concentration at the inlet on the substrate concentration at the outlet during a continuous fermentation; to obtain, in certain cases, positive values of the maximum growth rate during graphical determinations using the linearized form of the model; or to estimate the variations of the saturation constant as a function of the sludge age and the biomass fraction in each tank in the contact-stabilization process. A new model, which is drawn from Contois' model, is proposed and the equation for this model is presented and discussed. The proposed model is compatible with a limitation of the growth by accumulating inhibiting metabolites in the culture medium. It also keeps the possibility to characterize the limitation of the culture by exhaustion of the substrate and to take into account the substrate transfer resistance surrounding the microorganism. This formulation is shown to generalize the previous modeling processes by presenting Monod's, Contois's, Powell's, and Elmaleh's classical models as particular cases corresponding to particular values of the constants used. The application of this model to different effluents is demonstrated, and numerical values of the constants used are given. (Carroll-FRC)
W84-00324

LAND APPLICATION OF UNTREATED INDUSTRIAL WASTE WATER,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
L. D. King.
Journal of Environmental Quality, Vol 11, No 4, p 638-644, October-December, 1982. 8 Fig, 3 Tab, 10 Ref.

Descriptors: *Land application, *Wastewater irrigation, *Industrial wastewater, Denitrification, Wastewater disposal, Irrigation, Nitrates, Fate of pollutants, Pulp and paper industry, Heavy metals, Metals, Sodium, Wastewater treatment.

Untreated and treated wastewaters from a fiberboard mill were applied to fescue grass by spray irrigation for 4 years. The wastewaters varied widely in chemical composition over the study period. Initial application rate was 1.4 cm per week. After 2 years the untreated wastewater rate was changed to 1.5, 2.0, and 3.0 cm per week. 20%-30% of applied N was recovered in the harvested crop. Concentrations of Mn, Ni, Pb, and Cr in the unwashed crop were increased slightly, to levels well below the maximum tolerable in forage. Soil nitrate concentrations in untreated wastewater irrigation and control plots were not significantly different, except when the wastewater had very high nitrate levels. By the end of the study total N levels were higher in the 150-210 cm soil level near the surface; highest soil P was 150 ppm (untreated wastewater at highest application rate); highest soil Ca was >4000 ppm (untreated wastewater at 2 cm per week application); highest soil K was 340 ppm (untreated wastewater at highest application rate). Soil Na accumulated in the subsoil 136 ppm. This high concentration was attributed to a Na spill, pointing out the need for an equalization basin in the system. Soil pH was increased by the wastewater treatments to 7.4-7.8. Results showed that extensive pretreatment of wastewater before disposal to land did not significantly improve soil properties as compared with treated wastewater. (Cassar-FRC)
W84-00333

USE OF BIOLOGICAL FILTERS FOR TREATING AGRICULTURAL DRAINAGE EFFLUENTS,
Agricultural Research and Education Center, Sanford, FL.
K. R. Reddy, K. L. Campbell, D. A. Graetz, and K. M. Portier.
Journal of Environmental Quality, Vol 11, No 4, p 591-595, October-December, 1982. 4 Fig, 6 Tab, 19 Ref.

Descriptors: *Nutrient removal, *Aquatic plants, *Agricultural runoff, Wastewater treatment, Nitrates, Phosphates, Ammonium, Nitrogen removal, Phosphorus removal, Macrophytes.

Nutrient removal from agricultural drainage water was studied in a reservoir system containing aquatic macrophytes. The system, located near Lake Apopka, Florida, consisted of three reservoirs in series, each about 1240 cu m in volume, containing water hyacinth in R2, elodea in R3, and cattail in R4. The control reservoir (R5) contained Chara sp. but no macrophytes. Influent water contained 0.2 micrograms nitrate-N per liter, 0.1-1.0 micrograms ammonium-N per liter, 1.5-10.0 micrograms organic N per liter, and up to 2 micrograms per liter total P. Residence times were 3.6 days for R2 alone, 7.2 days for R2-R3, 9.4 days for R2-R3-R4, and 10.9 days for R5, the control. In the R2, R2-R3, R2-R3-R4, and R5 systems, respectively, removals adjusted for seepage losses were: nitrate-N, 81.1%, 91.5%, 92.1%, and 85.0%; ammonium-N, 78.1%, 77.8%, 80.0%, and 62.4%; organic N, 32.0%, 24.0%, 21.7%, and 6.2%; phosphate-P, 54.0%, 71.3%, 84.6%, and 58.5%; and total P, 32.2%, 43.6%, 66.2%, and 6.9%. (Cassar-FRC)
W84-00340

CONTROLLING COOLING TOWER PH AND CYCLES OF CONCENTRATION,
J. R. Hefler.
Industrial Water Engineering, Vol 19, No 3, p 24-28, May/June, 1982. 7 Fig, 7 Ref.

Descriptors: *Cooling towers, *Acidity, *Water treatment, Temperature effects, Humidity, Water quality, Carbon dioxide, Carbonates.

In open recirculation cooling systems the cooling tower pH must be controlled in response to external changes which are not controllable. These external changes include atmospheric temperature, humidity, and pollution levels, and makeup water quality. The most cost-effective operation can only be assured by precise determination of circulating water pH and its cycle of concentration, the two factors that can be controlled. In the acid addition system of control, stable wide-range acid feed is provided. A metering pump is used as the final control element to deliver acid at a rate independent of changes in viscosity, suction lift, or discharge pressure. The acid addition system should be interlocked with the circulating and makeup pump starters so that no acid is fed unless there is flow in the cooling system and the dilution pump is operating. Cooling water pH control is a means of suppressing carbonate ion and offsetting the loss of free carbon dioxide as the heated water is aerated. In addition to the acid addition system and pH control there are also systems for controlling the flow which regulate makeup to keep pace with evaporation and preset blowdown as a ratio of makeup. Cooling water chemistry is still far from being cut and dried. Considerable help can be obtained if the operation of all well instrumented systems were to be analyzed and compared. There are various technical societies which can be helpful in this regard. (Baker-FRC)
W84-00343

5E. Ultimate Disposal Of Wastes

A CASE STUDY OF DRY WELL RECHARGE,
Arizona Water Resources Research Center, Tucson.
L. G. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110865, Price codes: A04 in paper copy, A01 in microfiche. Completion Report, September 1983. 55 p, 15 Fig, 13 Tab, 10 Ref. OWRT A-114-ARIZ(1), 14-34-0001-1103.

Descriptors: *Urban runoff, *Waste disposal wells, Water pollution, Vadose water, *Recharge wells, Storm runoff, *Arizona, Tucson.

Five injection tests were conducted on an experimental dry well at a site near Tucson, Arizona. Goals of the tests were to determine (1) intake characteristics of the well, (2) flow patterns in the vadose zone, and (3) attenuation of urban runoff pollutant analogs (metals, microorganisms, and organic matter) in vadose zone/ground-water flow systems. Specific intake rates exceeded specific capacity values at a nearby pumping well. A perched ground-water system and a water table mound were observed by neutron moisture logging with lateral flow velocities averaging 500 ft/day. Metals were detected breaking through in a vadose-zone sampling well. Microbial tracers also arrived at the vadose zone sampling well, but peak values were markedly reduced below input values. The initial concentration of organic matter breaking through in the sampling well was 58% of the input values. No organic matter or microorganisms were detected in pumped ground-water samples. It was generally concluded that (1) dry well injection of urban runoff may develop perched ground water systems capable of spreading injected water within the radius of influence of nearby wells, and (2) given the pollutant loading rates of the test, ground water was not deteriorated in quality.
W84-00013

MAXIMUM APPLICATION RATES FOR LAND TREATMENT OF SEPTAGE,
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.
C. J. Clanton, R. E. Machmeier, J. L. Anderson, and M. J. Hansel.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111806, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Completion Report, Univ. of Minnesota, St. Paul, September 1983. 23 p, 8 Fig, 4 Tab, 12 Ref, 1 Append. OWRT A-045-MINN(2).

Descriptors: *Wastewater, *Septage, *Groundwater, *Land treatment, Soils, Nitrates, Phosphorus, Salts, *Application rates, Wastewater disposal.

Two years of data from a three year study indicates septage application rates of 1120 and 1500 kg/ha of nitrogen resulted in increased concentrations of nitrates in soil water extracts for a Hubbard loamy sand, Waukegan silt loam and Lester clay loam. Nitrate movement is quite slow through the Lester clay loam so that negative impacts of high rates of application will not be as great when compared to the silt loam or loamy sand. However, if the objective is to prevent movement of high concentrations of nitrates through the soils these application rates are too high. The application of septage did not affect the concentrations of fecal streptococcus and fecal coliforms in the soil water when comparing the treated plots for both years. This indicates that the soils evaluated have the capability to reduce the high level of fecal organisms found in septage to levels found normally in soil water. Septage application resulted in a significant increase in concentration of soil water calcium, magnesium, sodium and potassium during the first year. In addition, there was no increase in phosphorus concentration in the soil water.
W84-00040

DESIGN OF SEA OUTFALLS - THE LOWER LIMIT CONCEPT OF INITIAL DILUTION,
N. J. Bennett.
Proceedings of the Institution of Civil Engineers. Part 2: Research and Theory, Vol 75, No 1, p 113-131, 1983. 5 Fig, 1 Tab, 7 Ref.

Descriptors: *Outfall sewers, *Path of pollutants, *Mathematical studies, *Dye dispersion, *Wastewater disposal, Outfall, Coastal waters, Water currents, Design criteria, Statistical analysis, Tracers, Fate of pollutants, *England, East Sussex River.

A detailed sequel study was carried out by the East Sussex Water and Drainage Division of the Southern Water Authority. The study measured dye-sewage concentrations at the mouth and sea surface at the Hastings long sea outfall after 333 injections of Rhodamine WT dye within a diffuser port over a 3.5 month period. Ambient current, angle of ambient current relative to the diffuser, salinity, temperature and depth measurements were also recorded. Results of mathematical and statistical analyses of collected data showed that the formula derived by the Water Research Center for use in moving water conditions greatly underestimates dilutions and that the use of correction factors as a basis for measuring dilutions in moving water is not substantiated. A simpler, lower limit formula is proposed for use in sea outfall design which may be applied for the measurement of dilutions under a wide range of conditions. (Geiger-FRC)
W84-00076

WASTE-RELATED CADMIUM CYCLE IN SWITZERLAND,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5B.
W84-00078

RAYONIER PRODUCES ANIMAL FEED FROM SECONDARY SLUDGE AT SULFITE MILL,
J. C. W. Evans.
Pulp and Paper, Vol 57, No 3, p 124-126, March, 1983. 1 Fig.

Descriptors: *Sludge disposal, *Pulp and paper industry, *Dewatering, Industrial wastes, ITT Rayonier, Feeds, Pulp wastes, Sulfite mills, Carver-Greenfield evaporator, Evaporation, Biological wastewater treatment, Activated sludge process, Wastewater treatment, *Washington.

Sludge from the Rayonier Port Angeles, Washington, sulfite market pulp mill is converted into animal feed. This was the most suitable of 13 alternative sludge dewatering and disposal schemes evaluated. Pilot studies showed that the dry product had a protein content of 41-48% and a heat content of 9000 Btu. In the two-stage dewatering operation, the biomass from the secondary treatment plant is conditioned with polymers prior to belt filtration. The filtrate is returned to the secondary treatment plant, and the filter cake is sent to the second stage, a Carver-Greenfield evaporator system. With this process a metered quantity of oil is added to the sludge and the mixture passed through a series of multiple-effect, falling-film evaporators. Solids remain in the oil as a fluid slurry, which is centrifuged to recover the solids. Oil is recycled. This method of sludge disposal has no negative effects on water quality or the environment. (Cassar-FRC)
W84-00121

COMPOSTING OFFERS ALTERNATIVE FOR EFFLUENT PLANT SLUDGE DISPOSAL,
E and A Consultants, Stoughton, MA.
J. E. Alpert, E. Epstein, and C. De Groot.
Pulp and Paper, Vol 56, No 11, p 127-129, November, 1982. 2 Fig, 2 Tab.

Descriptors: *Sludge disposal, *Pulp wastes, *Composting, Industrial wastes, Aeration.

The Beltsville forced aeration sludge composting process is suitable for pulp and paper mill wastes. Raw sludge is mixed with a bulking agent such as bark or wood chips and piled 8 to 9 ft high over a perforated drainage pipe. A blower draws or blows air through the pile to maintain a desired temperature for the 2-6 week composting period. Finished compost can be sold as a soil conditioner or used by the paper mill itself for reforestation projects, odor scrubbing, or as fuel for boilers. Capital and operating costs for a 10 dry ton per day composting plant are $699,062 and $133,369, respectively. (Cassar-FRC)
W84-00175

SIMULATING LAND APPLICATION SITING EFFECTS ON WATERSHED HYDROLOGY,
Agricultural Research Service, Fresno, CA.
J. E. Ayars, M. Yaramanoglu, and H. N. Holtan.
Transactions of the ASAE, Vol 26, No 1, p 100-105, 1983. 5 Fig, 7 Tab, 5 Ref.

Descriptors: *Wastewater disposal, *Spray irrigation, Irrigation practices, Irrigation, *Land disposal, Waste disposal, Water quality, Hydrologic models, Model studies.

A hydrologic model was used to simulate the effects of land application of treated sewage effluent on the hydrologic response of a watershed. The effect of soil type, soil drainage characteristics and geology was tested on the disposal capacity of a land application system. Also, three conditions were used to initiate an irrigation: soil water was reduced to any value less than saturation; to 65% of available water capacity in the profile; and to 35% of available water capacity. Results demonstrated that base flow in a watershed is an important design parameter and that disposal rates needed to be matched to base flow and evapotranspiration potential. It was also shown that perennial cropping and frequent irrigation have the potential to increase disposal capacity. The study also demonstrated that a hydrologic model is a tool which provides a method to evaluate specific effects of a spray irrigation site on watershed hydrology which cannot be done easily in any other way. (Baker-FRC)
W84-00179

LAND APPLICATION OF UNTREATED INDUSTRIAL WASTE WATER,
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 5D.
W84-00333

5F. Water Treatment and Quality Alteration

THE ECOLOGY OF ACID-FAST ORGANISMS IN WATER SUPPLY, TREATMENT, AND DISTRIBUTION SYSTEMS,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
C. N. Hass, M. A. Meyer, and M. S. Paller.
Journal of the American Water Works Association, Vol 75, No 3, p 139-144, March, 1983. 9 Tab, 15 Ref.

Descriptors: *Chlorination, *Microorganisms, *Filtration, Bacteria, *Acid-fast organisms, *Water treatment, Water distribution, Fate of pollutants, Turbidity, Manchester, Concord, *New Hampshire.

Acid-fast organisms were well correlated with total coliforms throughout the Manchester and Concord, New Hampshire, water systems. Water from 8 locations in each system, from raw water to consumer, was sampled and analyzed for these organisms plus plate count, membrane standard plate counts, free and total chlorine residual, total organic carbon, pH, turbidity, and temperature. In raw water densities of acid-fast organisms correlated with concentrations of total coliforms and turbidity level. Acid-fast organisms were largely removed by sand filtration and further decreased in density with increasing distance from the treatment

plant. The acid-fast organisms were relatively resistant to chlorination and actually increased by 22% during chlorination at Concord. (Cassar-FRC)
W84-00022

KINETIC MODEL FOR OZONATION OF TOXIC WATER CONTAMINANTS,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
E. P. Minchew, F. M. Saunders, and J. P. Gould.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111889, Price codes: A02 in paper copy, A01 in microfiche. Environmental Resources Center Report No ERC 13-83, Georgia Inst. of Technology, Atlanta, September 1983. 16 p, 4 Tab, 7 Fig, 16 Ref. OWRT A-095-GA(1), 14-34-0001-1111.

Descriptors: Contamination, *Decomposition, *Kinetics, *Ozonation, *Ozone, Ozone decomposition, Hydrogenion concentration, Model studies.

A laboratory study was conducted on ozone decomposition kinetics in buffered water at various pH values. Ozone decomposition was shown to be highly dependent on pH, contaminant level, ozone concentration and UV irradiation. At pH values of 1.85 and 6.65, the order of the ozone decomposition was shown to be a function of ozone concentration and ranged from third-to zero-order for concentrations of 10 super -8.4 to 10 super -12 M. Accumulation of ozone-decomposition intermediates was shown to significantly effect the rate of ozone decomposition. The results of the study will aid greatly in evaluation of the oxidation of contaminant organics in waters and wastewaters and in determination of the relative rates of contaminant oxidation and ozone self-decomposition.
W84-00048

CONVENTIONAL WATER TREATMENT PROCESS OPERATES IN UNCONVENTIONAL MANNER,
Quicksall (W.E.) and Associates, Inc., New Philadelphia, OH.
J. S. Bachman, and J. R. Morgan.
Public Works, Vol 114, No 3, p 50-53, March, 1983. 2 Fig, 1 Tab.

Descriptors: *Ion exchange, *Water softening, *Brine disposal, Water treatment, New Philadelphia, *Ohio, Tuscarawas River, Manganese, Iron.

The water treatment plant at New Philadelphia, Ohio, is based on a pressure type sodium cycle ion exchange system, with concurrent removal of iron and manganese by pressure type manganese greensand filters. Waste brine regenerate is discharged into the Tuscarawas River. Design studies showed that at full operating capacity the plant would discharge 16,740 pounds of chloride daily into the receiving stream. This discharge would increase chloride concentrations in the river by 2.5 mg per liter at mean river discharge and by 16 mg per liter at low flow. This additional chloride load was acceptable to the Ohio EPA, since an upstream industry discharge raises chloride levels in the river to 450-900 mg per liter. Normal background levels of chloride are 26-30 mg per liter. The process uses split stream softening. About 80% of the flow is softened; the remaining 20% bypasses the softeners and is only treated for Mn and Fe removal. The brine discharge is spread evenly over a 24-hour period. The annual cost (capital amortization and operation/maintenance) is about half of a conventional lime-soda ash treatment plant (estimated at about $1 million for a 5 mgd plant). (Cassar-FRC)
W84-00120

FACTORS INFLUENCING THE ADSORPTION OF BACTERIA TO MAGNETITE IN WATER AND WASTEWATER,
Queensland Univ., Brisbane (Australia). Dept. of Microbiology.
I. C. MacRae, and S. K. Evans.
Water Research, Vol 17, No 3, p 271-277, March, 1983. 5 Fig, 6 Tab, 15 Ref.

Descriptors: *Bacteria, *Adsorption, *Magnetite, Water treatment, Sirofloc process, Wastewater treatment, Calcium, Magnesium, Hardness, Polyelectrolytes.

The interaction of bacteria and magnetite in the Sirofloc water treatment process was investigated. Magnetite particles pretreated with 8 cycles of alternating magnetization and demagnetization were not significantly more effective in removing 5 types of common bacteria than untreated magnetite. At low bacterial levels (10 million CFU per ml) the magnetite concentrations from 0.5-4% produced similar bacterial removals. At higher bacterial levels (665 micrograms per ml dry weight) 1-2% magnetite was required to remove 95% of the cells. Adsorption of bacteria was essentially complete within 10 min. with 1% magnetite in the presence of 11.13 mg per liter Ca and 9.62 mg per liter Mg adsorption of bacteria was 97-99% in the pH range 2.5-10.0. In the absence of Ca and Mg adsorption was 97-99% in the pH range 3-6 and 50% at pH 10. Addition of 0.5% Catoleum 8101 polyelectrolyte improved bacterial adsorption at magnetite concentrations of 0.05% and 0.10% but not at 0.25% and 1%. Bacterial removal from a wastewater effluent (hardness, 180 mg per liter as CaC03) was 70% in the first cycle and 98.1% in the second cycle. In the presence of Ca and Mg desorption of bacteria was very small: E. coli, 0.02%; Streptococus fecalis, 0.33%; Pseudomonas stutzeri, 6.28%. Without Ca and Mg 39.05% of E. coli were desorbed. (Cassar-FRC)
W84-00124

THE STABILITY IN WATER OF A NEW CHLORAMINE DISINFECTANT,
Auburn Univ., AL. Dept. of Chemistry.
S. D. Worley, W. B. Wheatley, H. H. Kohl, J. A. Van Hoose, and H. D. Burkett.
Water Resources Bulletin, Vol 19, No 1, p 97-100, February, 1983. 2 Fig, 14 Ref.

Descriptors: *Disinfectants, *Water treatment, *Bacteria, Purification, Stability, *Chloramines, 3-chloro-4,4-dimethyl-2-oxazolidinone, Chlorine.

The stability in water of a novel new chloramine agent, 3-chloro-4,4-dimethyl-2-oxazolidinone (I), has been compared to the stabilities of several other water disinfectants. Agent I proved to be remarkably stable in water solution and in dry storage. It also far exceeds all other agents tested in this work in this respect. Agent I could be termed as a slow release disinfectant which kills bacteria upon demand. Furthermore, its great stability and low percent dissociation to hypochlorous acid should prevent the formation of toxic trihalomethanes in treatment plants. The stability of agent I is certainly a desirable attribute which renders it of potential use as a disinfectant for small water supplies, swimming pools, cooling water for power plants, and possibly even for municipal treatment plants. Agents tested in this research included N-chlorosuccinimide, 2,4-dichloro-5,5-dimethylhydantoin, trichloroisocyanuric acid, calcium hypochlorite, commercial grade HTH, and household bleach. The total chlorine content of a water solution of agent I in a demand free environment remained constant over a period of at least 8 weeks. (Baker-FRC)
W84-00128

DEGRADATION OF ORGANOCHLORINE COMPOUNDS BY UV IRRADIATION WITH SIMULTANEOUS HYDROGEN PEROXIDE ADDITION UNDER WATERWORKS CONDITIONS (ABBAU VON ORGANOCHLORVERBINDUNGEN DURCH UV-BESTRAHLUNG BEI GLEICHZEITIGER WASSERSTOFF-PEROXIDE-ZUGABE UNTER WASSERWERKSBEDINGUNGEN),
Bremen Univ. (Germany, F.R.).
B. Stachel, B. Gabel, M. Cetinkaya, J. von Duszelen, and R. Kozicki.
Gas- und Wasserfach: Wasser/Abwasser, Vol 123, No 4, p 190-194, April, 1982. 4 Fig, 3 Tab, 43 Ref.

Descriptors: *Water treatment, *Oxidation, *Disinfection, *Ultraviolet, Hydrogen peroxide, Water analysis, Water quality, Organic compounds, *Organochlorine compounds, Agricultural chemicals, Hexachlorocyclohexane, Hexachlorobenzene, Heptachlor, Aldrin, Polychlorinated biphenyls, Dichlorobenzenes.

A study was made of the reduction of gamma-hexachlorocyclohexane (gamma-BHC), hexachlorobenzene (HCB), heptachlor, aldrin, polychlorinated biphenyl (2-PCB) and two dichlorobenzenes in water by UV-irradiation and simultaneous hydrogen peroxide addition. The study was designed to evaluate the UV/hydrogen peroxide method of disinfection and oxidation for water treatment. The reduction of these compounds under various hydrogen peroxide concentrations and water flux rates was measured. Reductions between 0 and 89% of the organochlorine compounds added were obtained. The reliability of the method was examined by error analysis, which gave an overall error for the method as a whole of 18.8%. Problems in the use of UV/hydrogen peroxide and capabilities of the method for purpose of water treatment include possible mutagenicity of hydrogen peroxide and its reaction products as well as the potential for formation of toxic intermediate degradation products. (Baker-FRC)
W84-00152

HYGIENIC EVALUATION OF ULTRAFILTRATION MEMBRANES PROPOSED FOR USE IN DRINKING WATER TREATMENT PRACTICES (GIGIENICHESKAYA OTSENKA UL'TRAFIL'-TRATSIONNYKH MEMBRAN V PRAKTIKE OCHISTKI PIT'EVOI VODY),
Moskovskii Gosudarstvennyi Meditsinskii Inst. (I) (USSR).
N. Ya. Mikhailovsky, A. A. Korolev, Yu. A. Rakhmanin, T. G. Shlepnina, and G. V. Merkurieva.
Gigiena i Sanitariia, No 8, p 8-10, August, 1980. 2 Tab, 7 Ref.

Descriptors: *Membranes, *Ultrafiltration, *Polysulfonamide, Toxicity, Laboratory studies, Filtration, Membrane processes, *Water treatment, *USSR.

New polysulfonamide ultrafiltration membranes of the 'Vladipor' type were evaluated under conditions simulating their actual use in water treatment. The membranes performed satisfactorily and did not affect the physical or chemical properties of the water. Permanganate oxidizability and brominated substance contents were similar for membrane-filtered and control water samples. Little or no alteration of biochemical parameters was seen in rats supplied with membrane-filtered drinking water for 6 months. Thus, the membranes are recommended for use in water purification facilities for domestic and industrial water supply systems. (Author's abstract)
W84-00156

GEOPROCESSING - A WATER DISTRIBUTION MANAGEMENT TOOL,
For primary bibliographic entry see Field 7C.
W84-00196

WATER SUPPLY IN DEVELOPING COUNTRIES: IMPROVING ON CURRENT PRACTICE,
A. D. Barrett, and M. B. Pescod.
Journal of the Institution of Water Engineers and Scientists, Vol 36, No 5, p 323-342, September, 1982. 4 Fig, 4 Tab, 24 Ref.

Descriptors: *Water supply, *Developing countries, *Planning, Design criteria, Urban water supply, Rural water supply, Water supply development, Management.

A critical review is offered of current practices in water supply in developing countries. The needs of developing countries for urban and rural water supply will only be met if adequate funds are made available during the United Nations International Water Supply and Sanitation Decade and if improvements are made in current practice, both in planning and implementation, including training, operation and maintenance. Design criteria and

standards are reviewed in terms of the quality of drinking water, quantity of drinking water to be provided, population to be supplied, and the proportion of standpipes to house connections. Urban and rural water supply is considered, using source selection and development techniques, water treatment, and water distribution. The subject of technology transfer contains reviews of local level education, on the job training, research and development and the role of international agencies. Water supply master plans and feasibility studies include demand forecasts, staging and time factors, cost considerations and engineering studies along with specialist studies, and project appraisals. (Baker-FRC)
W84-00198

HUGE SEAWATER PLANT PERFORMS AS PLANNED,
For primary bibliographic entry see Field 3C.
W84-00291

ON THE HYGIENIC EVALUATION OF N-NITROSAMINES AND THEIR TRANSFORMATION PRODUCTS IN WATER (K GIGIENICHESKOY OTSENKE NEKOTORYKH N-NITROZAMINOV I PRODUKTOV IKH TRANSFORMATSII V VODNOY SREDE),
Moskovskii Gosudarstvennyi Meditsinskii Inst. (I) (USSR).
A. A. Korolev, N. Ya. Mikhailovsky, and A. P. Ilnitsky.
Gigiena i Sanitariia, No 8, p 11-14, August, 1980. 3 Tab, 9 Ref.

Descriptors: *Nitrogen compounds, Chemical reactions, Water treatment, Chlorine, Ozone, Ozonation, Activated carbon, Carcinogens, Nitrosamines.

This study found that N-nitrosamines (NA) are highly stable compounds. The most effective methods for eliminating them from water were found to be ozonation and the use of activated charcoal filters. The NA transformation products that were formed under the action of chlorine and ozone are not as toxic as, and accumulate less than, the N-nitrosamines. NA chlorination products have a blastomogenic action, the mechanism of which appears to differ from that of the NA itself. (Author's abstract)
W84-00292

WATER TREATMENT FOR INDUSTRIAL BOILER SYSTEMS,
C. R. Peters.
Industrial Water Engineering, Vol 17, No 6, p 16, 18-26, November/December, 1980. 9 Fig, 1 Tab, 7 Ref.

Descriptors: *Boiler water, *Corrosion control, *Chemical precipitation, Water treatment, Phosphates, Amines, Steam, Heat transfer, Chelation.

The objectives of boiler water treatment are satisfactory steam purity, minimum corrosion, and minimum deposition. A variety of treatments are available to fit the needs of the many types of boiler systems, ranging from simple, natural circulation to high pressure systems with complex flow patterns and multiple components. Antifoam treatments can reduce carryover and improve steam purity. Examples are given for calculating the carryover and amounts of contaminants present in the steam. Deposits, which retard heat transfer, may be controlled by chemical additions to prevent formation of precipitates or to form precipitates easily removed by blowdown. Corrosion control must be tailored to individual boiler systems. Possible treatments include conventional phosphate treatment (maintenance of phosphate and hydroxide residual), coordinate phosphate treatment (trisodium phosphate residual with no free sodium hydroxide), congruent phosphate treatment (prevention of sodium hydroxide formation under hideout conditions), all volatile treatment (ammonia or hydrazine), chelants (ethylenediamine tetraacetic acid and/or nitrilotriacetic acid), and condensate/feedwater system treatment (hydrazine, neutralizing amines, or filming amines). A table lists guidelines for water quality for boiler feedwater and boiler water for pressures up to 2000 psig. (Cassar-FRC)
W84-00297

CHLORINATION OF ORGANIC COMPOUNDS: CHLORINE DEMAND AND REACTIVITY IN RELATIONSHIP TO THE TRIHALOMETHANE FORMATION. INCIDENCE OF AMMONIACAL NITROGEN (CHLORATION DE COMPOSES ORGANIQUES: DEMANDE EN CHLORE ET REACTIVITE VIS-A-VIS DE LA FORMATION DES TRIHALOMETHANES. INCIDENCE DE L'AZOTE AMMONIACAL),
Poitiers Univ. (France).
J. deLaat, N. Merlet, and M. Dore.
Water Research, Vol 16, No 10, p 1437-1450, October, 1982. 10 Fig, 7 Tab, 17 Ref.

Descriptors: *Chlorination, *Organic compounds, *Chlorinated hydrocarbons, Water treatment, Chloroform, Trihalomethanes, Ammonia, Phenols, Aromatic compounds, Aliphatic compounds.

Formation of chlorinated organic compounds, especially trihalomethanes, during chlorination of surface water was studied by chlorinating a number of organic compounds at concentrations of 0.000001 to 0.00001 mole in neutral medium. The aliphatic compounds, including acids, aldehydes, and alcohols, were relatively inert to chlorination. On the other hand, chlorine demands of 5-12 moles of chlorine per mole of organic precursor were obtained with aromatic compounds of the phenol and aniline types. Many organic compounds produced chloroform at molar yields of $<5\%$. Metapolyhydroxybenzenes and metachlorophenols were especially good precursors of trihalomethanes. Kinetic constants of chloroform formation are given for acetone, acetylacetone, resorcinol, phloroglucinol, and 3,5-dichlorophenol. Although chlorine demands of some compounds were very high, the chloroform produced accounted for only a small proportion. Chlorination of resorcinol produced large proportions of trichloroacetic acid (molar yield $<10\%$) and monochloromaleic acid (molar yield 60%). Chlorination of 3,5-dichlorophenol produced tetrahalogenated and pentahalogenated three-carbon compounds. Chloroform was also produced in significant amounts during chlorination of highly reactive precursors in the presence of ammonia or amine compounds. (Cassar-FRC)
W84-00319

NEW APPROACH TO COOLING WATER TREATMENT PROVIDES INCREASED PLANT PROFITABILITY,
E. W. Ekis, Jr.
Industrial Water Engineering, Vol 19, No 4, p 10, 12-15, 1982. 5 Fig.

Descriptors: *Cooling water, *Corrosion control, Water treatment, Nalco Delta-T System, Delta-T System, Biocides, Training, Process control, Industrial water.

The Nalco DELTA-T approach is designed to enhance plant profitability by optimizing cooling water treatment systems. The concept includes problem solving, program selection, program management, problem anticipation, and special services. Safety and efficiency of adding liquid biocides were improved by the Bioductor feed system, based on the Venturi principle. Hydrocarbon leaks into the cooling water system, difficult to detect and responsible for up to thousands of dollars per day in damages, are located with the aid of a specially designed sample collection device. The samples are extracted with Freon and analyzed by a portable spectrophotometer. In choosing a suitable treatment system four basic corrosion control approaches are in use: chromate/zinc, alkaline zinc, all organic, and stabilized phosphate. Choice of a program depends on the individual situation, whether pH upsets, elevated temperatures, iron contamination, or inorganic phosphate contamination are present. Operator training programs are available to improve treatment systems management. The Delta-T program anticipates problems and has plans for dealing with them. For example, an accidental acid overload may be promptly handled by using an iron dispersant to limit fouling during the critical period. The program also has special services, such as an on-line method for removing iron-based deposits from cooling systems without shutting down plant production. (Cassar-FRC)
W84-00335

TREATMENT TECHNIQUES FOR REMOVING ORGANIC COMPOUNDS FROM GROUND WATER SUPPLIES,
Pirnie (Malcolm), Inc., Paramus, NJ.
J. E. Dyksen.
Industrial Water Engineering, Vol 19, No 4, p 16-21, 1982. 3 Fig, 1 Tab, 7 Ref.

Descriptors: *Organic compounds, *Activated carbon, *Aeration, Water treatment, Adsorption, Groundwater, Solvents, Chlorinated hydrocarbons.

Aeration and granular activated carbon adsorption are the most practical and effective treatment methods for removing volatile organic compounds from groundwaters. Some groundwater supplies contain significant concentrations of solvents, trichloroethylene and tetrachloroethylene being found most frequently. Aeration equipment is classified into two categories: diffused aerators, where bubbles are passed upwards through the water, and waterfall aerators, such as cascades, multiple trays, spray nozzles, and packed columns. Well-designed packed columns can remove volatile organics with efficiencies $> 99\%$. Efficiency depends on several factors, especially the Henry's Law constant. Granular activated carbon is the best available broad spectrum system for removing volatile organics, but effectiveness of adsorption is uneven. Of the solvents usually found in groundwater, higher molecular weight compounds and unsaturated compounds are adsorbed better than lower molecular weight compounds and saturated compounds. Adsorption isotherms are not sufficient to design a system. Pilot tests are necessary to account for the competitive adsorption among the solvents present. Off-site regeneration of spent carbon is usually more economical than on-site regeneration. (Cassar-FRC)
W84-00337

RECOGNITION OF PIPE LEAKS BY SHORT TERM MEASUREMENTS (ERKENNUNG VON ROHRLEITUNGSLECKS DURCH KURZZEITMESSUNGEN),
F. G. Heide.
Gas- und Wasserfach: Wasser/Abwasser, Vol 123, No 4, p 181-183, April, 1982. 2 Fig, 1 Tab, 9 Ref.

Descriptors: *Water distribution, *Leakage, *Drinking water, Water conveyance, Measurement techniques, Measuring instruments, Flow measurement.

Many water utilities conduct routine leakage surveys at regular intervals of a few years to identify sources of leaks and to reduce leakage in drinking water distribution systems. New methods, such as leakage analysis, and new instruments, such as the leak noise correlator, have been successfully applied in an effort to improve the efficiency of the search for leaks. However, using these methods, leaks are only detected at the time such surveys are conducted. A new, permanent leakage control method has been developed which uses measuring stations which perform regular, automatic, short duration measurements of the night flow at 24-hour intervals to allow determination of when and where the search for leaks should start. (Carroll-FRC)
W84-00341

5G. Water Quality Control

A TEST OF THE WATER AND LAND RESOURCE ANALYSIS SYSTEM IN THE NEW JERSEY PINE BARRENS,
Cornell Univ., Ithaca, NY. Center for Environmental Research.
S. Pacenka, and K. S. Porter.

Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111848, Price codes: A04 in paper copy, A01 in microfiche. Completion Report, October 1983. 56 p, 20 Fig, 3 Tab, 2 Append. OWRT A-100-NY(1), 14-34-0001-2134.

Descriptors: *Technology transfer, Hydrologic budget, *Groundwater pollution, *Nitrogen cycle, *New Jersey, *Mathematical models, Groundwater recharge, Hydrologic cycle, Pine Barrens.

Technical tools to help determine how best to protect ground-water recharge from contamination are not widely available. This report summarizes an effort to apply an evolving set of such tools, the Water and Land Resource Analysis System (WALRAS), in the New Jersey Pine Barrens. The WALRAS was originally developed by Cornell University to aid ground-water management on Long Island, New York. The Pine Barrens have similar soils and climate to Long Island, making the transfer hydrologically feasible. The areas also share concerns over nitrate contamination of ground water. The project cooperators, Cornell University, Rutgers University, and the New Jersey Pinelands Commission, focused their efforts on a pilot study area near Hammonton, New Jersey. During the course of the project, a number of technical manuals about the WALRAS were developed, its component computer programs were improved, and a data base was assembled for the pilot study area. The transfer experience pointed out the need for computer access early in such a model-based project. It also illuminated the need for personnel skilled in multidisciplinary data interpretation and mathematical model application. The New Jersey team's companion report describes the results of the pilot area test.
W84-00044

A LINEAR PROGRAMMING ECONOMIC ANALYSIS OF LAKE QUALITY IMPROVEMENTS USING PHOSPHORUS BUFFER CURVES,
Economic Research Service, Washington, DC.
C. W. Ogg, H. B. Pionke, and R. E. Heimlich.
Water Resources Research, Vol 19, No 1, p 21-31, February, 1983. 6 Fig, 5 Tab, 27 Ref.

Descriptors: *Phosphorus, *Lake restoration, *Nonpoint pollution sources, Model studies, Greenlane Reservoir, *Pennsylvania, Economic feasibility, Cultivation, Erosion control, Water quality control, Eutrophied lakes, Soil erosion, Agricultural watersheds, Watershed management.

The economic feasibility of reducing phosphorus loads from agricultural land to a water supply reservoir was investigated using a linear programming model, which combines economic and physical modeling. Phosphorus loss coefficients were estimated using the Universal Soil Loss Equation for runoff and soil erosion and phosphorus buffer curves for labile P. The curves relate soil and solution P concentrations, assuming chemical equilibrium. The buffer curve approach using labile P instead of the traditional total P has several advantages, including the fact that labile P is more closely related to algal growth, soil P fertility, and crop productivity than total P. The model was applied to Greenlane Reservoir, the most severely eutrophied water body in Pennsylvania. The target total P level was established at 65 micrograms per liter, far less than the present 262 micrograms per liter, of which 60% comes from point sources and 40% from nonpoint sources. The model produced a variety of crop and conservation practices for four combinations of point-nonpoint labile P control. Some suggested changes were wider use of contour and no-till, shifting more acreage to hay production, and growing alfalfa on the steeper slopes. (Cassar-FRC)
W84-00082

RAYONIER PRODUCES ANIMAL FEED FROM SECONDARY SLUDGE AT SULFITE MILL,
For primary bibliographic entry see Field 5E.
W84-00121

HOW THE ROCKY MOUNTAIN ARSENAL IS HANDLING GROUNDWATER CONTAMINATION,
Rubel and Hager, Inc., Tucson, AZ.
For primary bibliographic entry see Field 5D.
W84-00133

INVESTIGATIONS OF STRATEGIES FOR REDUCING AGRICULTURAL NONPOINT SOURCES IN THE CHOWAN RIVER BASIN,
North Carolina State Univ. at Raleigh. Dept. of Biological and Agricultural Engineering.
F. J. Humenik, B. A. Young, and F. A. Koehler.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113562, Price codes: A09 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute Completion Report, September 1983. 172 p, 8 Fig, 29 Tab, 21 Ref, 6 Append. OWRT A-110-NC(1), 14-34-0001-1135.

Descriptors: *Nonpoint pollution sources, Agricultural runoff, *Agricultural watersheds, Erosion control, Nitrogen, Phosphorous, Biological samples, Soil absorption capability, *Management practices, *Chowan River Basin, Stream discharge data, Water quality data, Watershed soils.

A three-year study was conducted in the Chowan River Basin to measure water quality changes resulting from implementation of best management practices (BMP's) to reduce agricultural nonpoint sources. Important components of the overall study framework were to conduct surveys for assessing agricultural practices and producer attitudes associated with the development and evaluation of an agricultural nonpoint source control program and to conduct a supportive publicity, educational and technical assistance program. A cooperatively executed field sampling program resulted in over 13,000 actual USGS flow values, and 876 concentration samples. Predictive models were developed to fill data gaps and allow calculation of annual yields. The total complement of data obtained in this study emphasized the need of employing the total systems approach in conducting and evaluating nonpoint source control programs on a watershed basis. Important components of this total systems approach are recommendations to control agricultural nonpoint sources and methods for evaluating water quality changes. Study results lead to a better definition and documentation of the advantages and limitations of monitoring to determine actual land loading coefficients and to evaluate specific relationships between BMP's installed, and resulting water quality changes on a watershed basis.
W84-00134

SANITARY HYDROBIOLOGY AND HYDROPARASITOLOGY. GENERAL PRINCIPLES OF POLLUTION PROTECTION OF LAKE WATERS,
Limnologicheskii Inst., Irkutsk (USSR).
G. I. Galeziy.
Hydrobiological Journal, Vol 18, No 2, p 48-51, 1982. 5 Ref.

Descriptors: *Water quality control, *Lakes, Water pollution sources, Water quality, Benthos, Plant life, Physical properties, Microorganisms, *USSR, Lake Baikal.

Lake Baikal, an extremely pure water lake, was monitored for the slightest changes in the water, and the entire ecologic system of the adjacent region was also studied to try to develop strategies and tactics for the protection of other lakes which unavoidably experience the effect of human activity. In the zone of discharge of the purified effluent of the Baikal pulp and paper mill some restructuring of the benthic biocenoses has already occurred. Four species of mollusks were found in the local zone where cellulose and lignin are deposited on the bottom. The groups of microorganisms have also changed. All of these changes have been induced by the effluent, the mineral salt content of which conforms to the level established for potable water. The results of many years of study suggest that it is practically impossible to protect such lakes and streams from pollution unless consideration is given to their specifics. Attention must be given to the species composition therein, physiology and functioning of the organisms which populate them, the stability and reproduction of hydrobiocenoses, the geographic position of the lake, its size, depth and volume of water in it, and other factors. Only when these are considered can measures be developed to preserve water quality, the natural properties of lakes and the surrounding plant and animal life. (Baker-FRC)
W84-00147

MANAGEMENT OF THE WATER-TABLE IN ALSACE. PROPOSAL FOR A PATRIMONIAL MANAGEMENT (LA GESTION DE LA NAPPE PHREATIQUE D'ALSACE. PROPOSITION POUR UNE GESTION PATRIMONIALE),
P. Gendrin.
Techniques et Sciences Municipales, No 2, p 89-92, February, 1981. 6 Ref.

Descriptors: *Water resources development, *Water quality management, Water management, Management planning, Groundwater management, Administrative agenies, France, Alsace.

Due to the favorable conjunction of the limits of the Alsatian region and of the presence of a very important groundwater reservoir, it is proposed that a regional patrimonial institution be created to manage the Alsatian water resource at its sources--both surface and underground--prior to any appropriation for exploitation of this water. The aim of such a regional institution would be to preserve the quality of the groundwater, which is currently inadequately protected against pollution from the soil surface which results from the remarkable economic development and urbanization which has occurred in Alsace during the last decades. The proposed solution involves resorting to a water resources management program proceeding on multiple levels and through multiple partners. It is recommended that the management be of the patrimonial type and take into account, before any decision regarding water resources, all present and future concerned interests. (Carroll-FRC)
W84-00306

CONTROLLING COOLING TOWER PH AND CYCLES OF CONCENTRATION,
For primary bibliographic entry see Field 5D.
W84-00343

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

CALIBRATION OF LARGE-SCALE ECONOMIC MODELS OF THE AGRICULTURAL SECTOR AND RELIABLE ESTIMATION OF REGIONAL DERIVED DEMAND FOR WATER,
California Univ., Davis. Dept. of Agricultural Economics.
R. E. Howitt.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110857, Price codes: A03 in paper copy, A01 in microfiche. California Water Resources Center Completion Report, Univ. of California, Davis, August 1983. 32 p, 9 Fig, 3 Tab. OWRT A-087-CAL(1).

Descriptors: *Model studies, *Regional planning, *Calibrations, *Linear programming, Costs, Water resources planning, Water resource management, *Water demand, Irrigation, *California.

Given the importance of regional response in physical and economic terms to water resource planners, large scale regional models are a widely used component of water resource management. Given the absence of a sufficiently rich data base to estimate cost functions by econometric approaches, linear constrained optimization models have been extensively used to derive normative estimates of former response to water policy. A long standing problem in linear models is the inevitable trade-off between the precision of calibration

of the model and the constrained nature of the solution. Often model results significantly depart from empirical reality with deleterious effects on policy. This research shows that a nonlinear cost function formulation overcomes the constraint problem when the function parameters are estimated from actual farmer responses. The Positive Quadratic Programming (PQP) theory developed was applied to the California Agricultural and Resources Model (CARM) and used to estimate demand functions for irrigation water by region. (Snyder-California)
W84-00012

GUIDELINES FOR INTERACTIVE COMPUTER SOFTWARE IN WATER RESOURCES ENGINEERING,
Advanced Engineering Software, Irvine, CA.
T. V. Hromadka, J. M. Clements, and G. L. Guymon.
Water Resources Bulletin, Vol 19, No 1, p 91-96, February, 1983. 3 Fig, 5 Ref.

Descriptors: *Water resources development, *Computers, Hydrology, Microcomputers, Programming, Training, Software, Decision making, Water management, Planning.

A case study is presented in the preparation of humanized computer software for water resources engineering studies. Considerations are included of what should be in a computer software library development plan. A brief presentation of humanized software guidelines is included along with the use of the programming techniques for computer aided design. The techniques presented provide an application of state-of-the-art programming techniques to water resources engineering programming needs. By establishing a uniform user-friendly set of program guidelines at an agency or firm, the program training expenditure associated with new program users is minimized. Additionally, errors in program usage is virtually eliminated due to the ease of program use. The techniques provided are employable on most computers of the mainframe and minicomputer classes, as well as many currently available microcomputers. Generally, no formal training is needed for program use, and no program user's manuals are needed. Since water resources related studies and design problems generally involve significant computational effort with multiparameter models, the capability to conduct several studies exploring various design alternatives or model parameter sensitivity is needed. However, by using humanized software the costs of such iterative studies is significantly reduced. For example, a Southern California runoff hydrograph procedure generally costs about 40 man hours of a hydrologist's time. Using humanized programming, a hydrograph can be developed in less than 10 minutes' time. Consequently, water resources firms should explore and incorporate a standard humanized software plan into their company software development program. (Baker-FRC)
W84-00113

WATER CONSTRAINTS ON ENERGY DEVELOPMENT: A FRAMEWORD FOR ANALYSIS,
California Univ., Berkeley. Div. of Energy and Environment.
J. Harte.
Water Resources Bulletin, Vol 19, No 1, p 51-57, February, 1983. 1 Fig, 14 Ref.

Descriptors: *Water resources development, *Energy conservation, Water supply, Drought, Energy sources, Fuel, Water demand, Management, Decision making, Stochastic processes.

A study of the impacts of future energy development on freshwater resources was carried out as part of the US National Academy of Sciences' CONAES study. The results led to the identification of severe constraints on US energy development that could arise in the future due to geographic and temporal variability of the freshwater resource. In order to obtain a rational resolution of the political problems that will be generated in the future it is necessary that planning based on predictions of future energy supply and demand be replaced by scenario or 'what if' analyses; that full attention be paid to the uncertainties in per-unit-energy water requirements; that suitable stochastic measures of water availability be used to compare water supply with water demand; that realistic ecological criteria, and other alternative use criteria, be developed for estimating impacts of water withdrawn or consumed for energy development; and that human consequences of ecological impacts be described in a manner that will allow the political process to intervene in an optimum manner to allocate water resources. (Baker-FRC)
W84-00115

URBAN STORMWATER MANAGEMENT NEEDS IN NORTH CAROLINA,
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
H. R. Malcom, and J. M. Sappington.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113687, Price codes: A06 in paper copy, A01 in microfiche. Water Resources Research Institute Report No 199, August 1983. 111 p, 10 Fig, 11 Tab, 36 Ref, 2 Append. OWRT B-116-NC(1), 14-34-0001-9125.

Descriptors: *Storm runoff, *Institutional constraints, Stream degradation, Stream erosion, *Urban watersheds, *North Carolina, *Stormwater management, Water quality.

Current practices in stormwater management were examined to provide recommendations for improvement, particularly in the areas of institutional arrangements and technical support. Because of fragmented institutional arrangements and site-specific conventions of design, the network of urban streams suffers from lack of comprehensive treatment of problems of flooding, sedimentation and inferior water quality. If public perception of the value of a better-performing urban stream system is sufficiently well formed to support systematic improvement, the approach recommended is to reform the current fragmented system into a stormwater public utility in parallel to those of water, sewer and street systems. Set at the local level, the public-utility approach would provide for the needed comprehensive planning, design and management. The principal analytical resource needed is that of watershed modeling to simulate urbanizing watersheds adequately for making the planning and design decisions respecting the interactions of system components. A micro-computer program was prepared which uses impulse analysis for the study of streambank behavior under the influence of varying hydrograph shapes. The program, user instructions and case studies are given. An annotated bibliography of reference materials on project topics is included.
W84-00166

CONSTRUCTION OF AN INTEGRATED AND ECONOMICALLY EFFICIENT WATER ALLOCAION PROCESS FOR THE FLINT RIVER,
Georgia Univ., Athens. Inst. of Natural Resources.
H. F. Wright, and R. M. North.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-117241, Price codes: A04 in paper copy, A01 in microfiche. Environmental Resources Center Report No ERC 15-83, Georgia Inst. of Technology, Atlanta, September 1983. 50 p, 2 Fig, 1 Tab, 35 Ref. OWRT A-104-GA(1), 14-34-0001-2111.

Descriptors: Allocation, Flint River Basin, *Georgia, Water budget, State water plan, *Water allocation, *Water law, *Water permits, Water prices, Water resources management.

The economic theory of common property resources, as they exist in the Flint River Basin, are described as a prerequisite to establishing a river basin management strategy. Three alternative approaches are presented as they might be applied to a management strategy that integrates water quality with water supply decisions for both surface waters and ground waters. The principal focus is on identifying the relationship between existing legal institutions and economically optimum allocation mechanisms. Specific management concerns are identified for the Flint River Basin and each concern is addressed in terms of the implications of a proposed marketable water rights system that would include water quality (pollution rights) and water supply (withdrawal rights). This type of system would be implemented only as overall scarcities of the water resources increased its value substantially above any transaction costs of establishing the system. The trading aspect will be many years off but the principle of allocations is sequentially higher valued uses through the effluent withdrawal permitting processes on a gradual (attrition type) basis.
W84-00199

WATER RESOURCES PLANNING IN THE SUSA-BASIN BY MEANS OF A SIMULATION MODEL,
Technical Univ. of Denmark, Lyngby.
J. Knudsen, and D. Rosbjerg.
Nordic Hydrology, Vol 13, No 5, p 323-338, 1982. 18 Fig, 1 Tab, 4 Ref.

Descriptors: *Water resources planning, *Model studies, Susa Basin, Denmark, Catchment areas, Water supply, Waste water disposal, Recreation, Irrigation, Water use, Water demand, Planning.

As part of the Susa project a combined hydrological/water quality simulation model was developed for water resource planning purposes. The model provides a detailed analysis of the consequences of meeting the demands of conflicting interests, including water supply, wastewater disposal, irrigation, and recreation. The recognition of the mutual dependency of each of these interests is crucial to ensure overall coordination of water resources utilization. This recognition is indispensable for providing a sound basis for political decisions on future water resource developments. It is shown that it is possible to establish a unified system of models, enabling multiple effects of water resource dispositions to be analyzed. By employing such models to assess hydrological, water quality and economic impacts of different alternatives, the information base for the final decisions can be substantially improved. (Baker-FRC)
W84-00326

6B. Evaluation Process

WATER RESOURCES IN ISRAEL AND THE NEED FOR DESALINATION,
Ministry of Agriculture, Tel-Aviv (Israel). Water Commission.
For primary bibliographic entry see Field 3A.
W84-00261

PAST DEVELOPMENTS AND PROBABLE EVOLUTION OF THE STRUCTURE AND ORGANISATION OF SERVICE STAFF IN THE WATER SECTOR AS A RESULT OF THE INTRODUCTION OF AUTOMATION (EVOLUTION PASSEE ET PREVISIBLE DE LA STRUCTURE ET DE L'ORGANISATION DU PERSONNEL DU SERVICE DES EAUX, RESULTANT DE LA MISE EN PLACE D'AUTOMATISMES),
Compagnie Generale des Eaux, Paris (France).
M. Rapinat.
Aqua, No 1, p 241-244, 1981. 7 Fig.

Descriptors: *Automation, *Personnel management, *Manpower, Computers, Water treatment facilities.

Automation in water services in the past has profoundly shaken the structure and organization of personnel in this industry. It is likely that the new forms of automation currently being considered for application in water management will bring changes affecting new groups of personnel in this field. In the past, automation was implemented to economize on the use of technical personnel and to increase the effectiveness of certain water purification stages. These changes resulted in an improvement in working conditions, a reduction in posted personnel, and a significant need for re-training in the use of new techniques, which resulted in an improvement of employee qualifications. These changes had no significant effect on administrative

activity. However, the efficiency and flexibility of new automation devices based on programming will have a considerable effect on requirements for administrative personnel and only a minor effect on the need for personnel in the technical domain. The objectives of these types of automation will be to improve the economic factors bound to operation, to reduce the number of posted personnel, and to further improve working conditions. Current progress in automation in water services can be expected to result in cost reduction, water quality improvement, improved working conditions, and upgrading of personnel. (Carroll-FRC)
W84-00309

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ANALYSIS OF TAX INCENTIVES FOR INTENSIVE IRRIGATION DEVELOPMENT IN THE NEBRASKA SANDHILLS,
Nebraska Univ.-Lincoln. Dept. of Agricultural Economics.
M. E. Baker.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110782, Price codes: A02 in paper copy, A01 in microfiche. Nebraska Water Resources Center Completion Report, September 1983. 12 p, 3 Ref, 1 Append. OWRT A-070-NEB(1), 14-34-0001-2129.

Descriptors: *Land development, *Investment, *Tax rate, Regulations, Management analysis, Farm managment, Irrigated land, *Economic justification, Economic prediction, Benefit-cost analysis, *Nebraska, Tax incentives, Irrigation development, Cash flows, Return on equity.

The overall objective was to quantify tax incentives for concentrated irrigation development in the Nebraska Sandhills. Budgets for investments, costs and returns for crop production and analysis of resulting income tax liabilities were simulated for case studies of irrigation developers who were: (1) ranchers, (2) farmers, (3) long-term investors, and (4) short-term investors. The unit of analysis was one center pivot system on a quarter section of former Sandhills rangeland. The returns on equity ran over 60% per year in some years for some investors. Likewise, returns of 4 to 6% per year were also common. The wide range reflected the effects of income tax regulations which permit deduction of interest and depreciation. The short-term investors maintain high returns on equity by liquidating after every fifth year. Reinvesting to tax shelter this income permits the development of 3 new quarters from the proceeds of the first one. For most investors, before-tax cash flows were negative until the loan on the well and center pivot was retired. Thus, for most investors, nonfarm income or income from other farm enterprises was required to supplement revenue from irrigated crop production during the repayment of well and pivot loans. After-tax cash flows were positive for all simulated cases. The flows increased with increases in leverage and marginal tax rates.
W84-00005

COMMENTS ON THE NATIONAL WATER COUNCIL'S CONSULTATION PAPER 'CHARGING HOUSEHOLDS FOR WATER'.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 2, p 105-108, March, 1981.

Descriptors: *Water metering, Economic justificaton, *Water rates, Economic aspects, *Economic feasibility, Cost sharing, Expenditures, Marketing, Payment, Prices, *Domestic water.

The Institution of Water Engineers and Scientists have replied to the National Water Council's paper dealing with various methods by which households could be charged for water service. Three major issues have necessitated changes in charging policies as they now stand. These influences were: the Water Act of 1973, which imposed a legal requirement on water undetakings to introduce charging systems by April of 1981 that show no undue preference or discrimination between classes of ratepayers; the introduction of direct billing by water authorities, highlighting the cost of combined water services; and the highly capital-intensive character of the water industry's operations, leading to more than half of the revenue from charges being absorbed by the servicing of capital expenditure, thus causing faster increases in consumers' charges than the general rate of inflation. The Institute notes that there is a clear attempt to improve the efficiency, reliability and general technology of metering. However, it is suggested that optional metering is to some degree a financial palliative. The Institute feels that the actual adoption of metering will not be significant except than in the commerical sector. The thoughts of a member of the Institute are also published; he urges that further consideration be given to how other countries manage their charging systems before moving toward optional metering. (Baker-FRC)
W84-00015

IMPACT ON RESIDENTIAL WATER CONSUMPTION OF AN INCREASING RATE STRUCTURE,
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
C. E. Young, K. R. Kinsley, and W. E. Sharpe.
Water Resources Bulletin, Vol 19, No 1, p 81-86, February, 1983. 3 Fig, 4 Tab, 20 Ref.

Descriptors: *Water conservation, *Water rates, Water supply, Water resources development, Economic aspects, Public policy, Metering, Pricing.

A two-step procedure is described for use in estimating the impact of an increasing rate structure on residential water use. An error components regression procedure is used to estimate demand relationships for a period prior to the rate change. Water use is predicted for the post rate change period, assuming that the rate structure was not changed. Comparison of actual with predicted use indicates that water use declined as a result of the imposition of the increasing rate structure. Average residential water use in the WSSC's service area has been decreasing since 1974. A portion of this decreasing trend can be attributed to the overall success of the WSSC's water conservation programs. Additional reductions in water use resulted from the imposition of an increasing rate structure for water on January 1, 1978. Comparison of actual use with estimated use, assuming that the increasing rate structure was not instituted, revealed that actual use decreased in 1978 and 1979. Estimated reductions in water use ranged from 1.1 to 8.7%. A portion of this decreased use can be attributed to changes in water use habits. It remains to be seen whether or not these habit changes are maintained after the WSSC's customers become accustomed to the new rate structure. (Baker-FRC)
W84-00100

CHANGES IN WATER POLICY IN THE PEOPLE'S REPUBLIC OF CHINA,
Purdue Univ., Lafayette, IN. Dept. of Political Science.
L. Ross.
Water Resources Bulletin, Vol 19, No 1, p 69-72, February, 1983. 2 Tab, 9 Ref.

Descriptors: *Water policy, *Metering, *Water demand, Water use, Conservation, Water conservation, *China, Policy, Public policy, Regulations, Economic aspects.

A major change has taken place in the last few years in the regulation of water usage in China. This change was encouraged by the occurrence of severe drought in the north China plain, including the politically important cities of Beijing and Tianjin. The drought enhanced the prominence of economics as part of the current modernization drive (control of water use through price regulation). China's cabinet recently committed the country to the introduction of metering and usage sensitive pricing along with other conservation measures. However, the speed at which metering can actually be carried out and the quality of managment which will be given the endeavor are uncertain at this time. The high hopes currently placed on these measures may be exaggerated. Since individual meters will be costly to install and difficult to monitor, group meters are likely to be widespread, creating problems of group incentives and mutual supervision. Further, utility companies which are owned by the state may require additional rate making assistance if their sales decline too precipitously. China's present consumption also is very low. As the economy develops additional water supplies will be required, although market solutions should reduce and slow down the need for new supplies. Political opposition may yet arise in response to the wide use of markets to force conservation, as this would be ideologically opposed to much of the political climate in the country. (Baker-FRC)
W84-00102

PRICING AS A POLICY TO REDUCE SEWAGE COSTS,
Maryland Univ., College Park. Dept. of Agricultural and Resource Economics.
M. Strudler, and I. E. Strand, Jr.
Water Resources Research, Vol 19, No 1, p 53-56, February, 1983. 1 Tab, 16 Ref.

Descriptors: *Costs, *Wastewater treatment, *Pricing, *Maryland, Elasticity of demand, Water rates, Economic aspects, Water pollution control.

Compliance with the Federal Clean Water Act is expected to cost $3 billion for the state of Maryland, of which $1 billion must be paid by the citizens and $2 billion is available from federal grants. Reducing sewage flows by charging a modest water/sewage fee for residential water use ($2 per thousand gallons) would reduce costs of compliance by a total of $21 million. Of 61 facilities, 29 charge nothing for use or disposal of water and 16 have a per capita daily use greater than 100 gal. Twenty-one towns with no water charge or a water charge less than $2 per thousand gal and a daily per capital use of more than 100 gal were used in a cost analysis. Raising the water charge to $2 per thousand gal in these towns would reduce daily sewage flow by 1.9 million gal and reduce annual costs by $14.4 million. Largest cost savings would be in Patpsco ($5.3 million), Savage, ($1.6 million), Bowling Green ($1.5 million), Frederick ($1 million), and Chestertown ($910,000). The elasticity of disposal demand was estimated to be -0.07. Thus a 14% increase in prices would decrease sewage flow by about 1%. (Cassar-FRC)
W84-00131

6D. Water Demand

ADAPTING WATER SERVICES TO URBAN GROWTH: A CASE STUDY OF SALT LAKE COUNTY,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 6E.
W84-00031

WATER REQUIREMENT FOR COAL SLURRY TRANSPORTATION,
Kentucky Water Resources Research Inst., Lexington.
D. T. Kao, and S. L. Rusher.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111749, Price codes: A06 in paper copy A01 in microfiche. Research Report No 146, September 1983. 104 p, 17 Fig, 14 Tab, 36 Ref, 2 Append. OWRT A-089-KY(1), 14-34-0001-2119.

Descriptors: *Water demand, *Water allocation, Slurries, Pipe flow, Pipelines, Coal, *Water requirements, *Coal slurry pipelines, Coal slurry transportation, Coal slurry pipeline design.

The amount of water required for coal slurry transportation is a function of coal properties and the magnitude of coal movement. The pipeline system characteristics and the method of slurry preparation also effects the overall water requirement of the system. In the present study methodologies are developed based on reported and modified coal slurry flow correlation equations to determine the quantity of water needed under various

coal transport and flow conditions. Auxiliary water requirements including start-up and flushing water storage; related evaporation and seepage losses are also included. A computer program and several monographs are presented to provide a quantitative estimation of water requirements for fine to coarse coal slurry transport. The results are useful to the slurry pipeline design engineers in providing essential information for state and local water allocation policy determination.
W84-00034

CHANGES IN WATER POLICY IN THE PEOPLE'S REPUBLIC OF CHINA,
Purdue Univ., Lafayette, IN. Dept. of Political Science.
For primary bibliographic entry see Field 6C.
W84-00102

WATER CONSTRAINTS ON ENERGY DEVELOPMENT: A FRAMEWORD FOR ANALYSIS,
California Univ., Berkeley. Div. of Energy and Environment.
For primary bibliographic entry see Field 6A.
W84-00115

WATER SUPPLY IN DEVELOPING COUNTRIES: IMPROVING ON CURRENT PRACTICE,
For primary bibliographic entry see Field 5F.
W84-00198

DEVELOPMENT OF A PROTOTYPE SOFTWARE PACKAGE FOR PROJECTING WATER DEMAND AT THE SUBCOUNTY LEVEL,
Delaware Univ., Newark. Coll. of Urban Affairs and Public Policy.
E. C. Ratledge.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-117258, Price codes: A03 in paper copy, A01 in microfiche. Delaware Water Resources Center Completion Report, October 1983, 36 p, 24 Tab. OWRT A-057-DEL(1), 14-34-0001-2108.

Descriptors: *Data processing, Population dynamics, Planning, Growth rates, *Water demand, Water management, Administrative decisions, Water use, Projections, Water distribution, Mathematical studies, Prediction, Public policy, *Delaware, *Local governments.

A prototype software package which would produce alternative estimates of water demand at the subcounty level was developed. The design dictated the use of data which was routinely available in a large number of jurisdictions. Further, the software had to be flexible in order to allow testing of alternative assumptions and to accept new data as actual population, employment, or water demand data became available. The tool is designed for use by managers of water resources; however the design is flexible enough to permit estimation of many population-based service demands.
W84-00200

WATER RESOURCES PLANNING IN THE SUSA-BASIN BY MEANS OF A SIMULATION MODEL,
Technical Univ. of Denmark, Lyngby.
For primary bibliographic entry see Field 6A.
W84-00326

6E. Water Law and Institutions

LEGAL ASPECTS OF WATER RESOURCES: A SURVEY OF THE LAW IN GEORGIA,
Georgia Univ., Athens. Inst. of Natural Resources.
J. O. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110816, Price codes: A12 in paper copy, A01 in microfiche. Environmental Resources Center Report No ERC 05-83, Georgia Institute of Technology, Atlanta, April 1983. 255 p, Ref.(footnoted). OWRT A-101-GA(1), 14-34-0001-2111.

Descriptors: Drinking water, Erosion, *Georgia, Groundwater, Hazardous waste, *Legislation, Marshland protection, Permit systems, Pollution control, *Regulation, Sedimentation, Shore protection, Surface water law, Water administration, *Water allocation, *Water law, *Water permits, *Water quality, Water quality protection, Wetland protection.

In the decade of the 70's, the Georgia and Federal legislatures virtually rewrote the body of substantive law affecting water resources. The approach of the Georgia legislature, that portion of the law of the period which is addressed in this report, was to initiate change in areas it perceived needed to be changed and to respond positively to Federal initiatives that otherwise would have preempted State authority in broad areas of natural resources/water law traditionally administered by the State. The result has been an important accumulation of statute law and regulation which treats comprehensively the important issues of water resource protection and allocation.
W84-00008

ADAPTING WATER SERVICES TO URBAN GROWTH: A CASE STUDY OF SALT LAKE COUNTY,
Utah Water Research Lab., Logan.
D. T. Larson, K. R. Kimball, C. W. Hiibner, and J. M. Bagley.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111715, Price codes: A06 in paper copy, A01 in microfiche. Water Resources Planning Series UWRL/P-83/05, August 1983. 105 p, 14 Fig, 21 Tab, 122 Ref. OWRT B-208-UTAH(1), 14-34-0001-1272.

Descriptors: *Institutional constraints, *Legal aspects, *Local governments, Water districts, *Political constraints, Political aspects, Utilities, Utility extension, *Urban planning, Community development, Water supply, Municipal water, Municipal wastewater, *Utah, Salt Lake County.

Urbanizing areas throughout the nation are considering governmental reorganization or consolidation to coordinate planning and improve the cost effectiveness of the delivery of public services. More efficient water supply and wastewater services may become important in the political debate over reorganization. However water factors figure politically, accomplished reorganizations must carefully plan for efficient provision of water services. This study profiles the structure and interactions of municipalities and water service agencies in Utah's Salt Lake County during the 1970s. Both 1975 and 1978 attempts to consolidate Salt Lake City and the unincorporated area of the County failed. The voting patterns, interest group positions, and issues are examined. One major water issue surfaced in a concern that service jurisdictions and financial obligations were not sufficiently defined to protect the communities previously bound through water service agreements but excluded from the consolidated government. Additionally, the proposed dissolution of the County water conservancy district raised doubts on the division of equity in water rights and distribution facilities. Any large water development stabilizes institutional arrangements to a degree which may become a financial and legal constraint to desired change. Overall, nonwater issues dominated the decision in this water sensitive area. This implies that water service jurisdictional alignments are set by political decisions based on nonwater considerations. Water utilities must do their best to be effective in the resulting context.
W84-00031

1973-1983 SUPPLEMENT TO SURVEY OF OREGON'S WATER LAWS,
Oregon Univ., Eugene. School of Law.
C. D. Clark.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111764, Price codes: A12 in paper copy, A01 in microfiche. Water Resources Institute Publications WRRI-81, Oregon State Univ., Corvallis, September 1983. 254 p, 108 footnotes plus statute and case citations. OWRT A-057-ORE(1), 14-34-0001-2139.

Descriptors: *Water law, *Water rights, *Appropriation, Boundary disputes, Liability, Negligence, Ownership of beds, Permits, Property boundaries, *Riparian rights, *Oregon.

Oregon water law was initially based upon the riparian and appropriative doctrines as proprietary systems for the allocation of water resources. State interest was first asserted systematically in the 1909 Surface Water Code. It abolished inchoate riparian rights, provided for the adjudication of pre-1909 vested rights, established a permit system for surface water use, and provided for state administration of water rights. Various enabling statutes have since provided for eight water management districts. Over time, the legislature withdrew streams from appropriation for scenic and municipal water supply purposes. A 1927 Groundwater code was applied to eastern Oregon. It was replaced in 1955 by a comprehensive Groundwater Act. Also in 1955, a water planning statute created a Water Resources Board with authority to classify waters for future use and to establish minimum stream flows for fish life. Since 1955 planning has been accomplished though 12 basin program statements; 19 watermaster districts provide field assistance and enforcement water laws. In 1975 the Oregon legislature merged the State Engineer's office and the Water Resources Department. Since 1975, a basic problem has been the scarcity of funds to complete adjudications, to establish critical groundwater areas, to staff the 19 watermaster districts, and to update the 12 basin program statements. The effort to determine navigability and state ownership of the beds of navigable streams was aborted by the 1983 legislature. The 1983 legislature also emphasized the creation of minimum stream flows. Oregon has considerable case law on problems relating to water boundaries, water drainage, and liability for escaping water.
W84-00036

THE CONTINUING EVOLUTION OF AN AUSTRALIAN WATER RESOURCES POLICY,
Macquarie Univ., North Ryde (Australia). School of Earth Sciences.
P. Crabb.
Water Resources Bulletin, Vol 19, No 1, p 23-28, February, 1983. 1 Fig, 1 Tab, 42 Ref.

Descriptors: *Water resources development, *Legislation, *Australia, Regulations, Policy, Water management, River Murray, Rivers, Water demand, Water supply.

The limited water resources of Australia highlight the need for policy guidelines for water management. A gradual evolution of a national water resources policy took place during the 1970s, facilitated by a nationally agreed statement of objectives and culminating in a federal policy statement presented in 1979. However, the Australian constitution delegates the major responsibility for water resources to the states. The federal policy statement seems to assume that each state has a water resources policy and that it accords with the nationally agreed objectives. This is not the case, and the practical management of Australia's water resources falls short of the principles set out in the document of policy. The River Murray, which is the nation's major water resource, provides ample evidence of this fact. In view of its very limited water resources it is urgent that Australia reduce the disparity between principle and practice in their management. (Baker-FRC)
W84-00088

WATER RESOURCES ORGANIZATIONS IN GEORGIA,
Georgia Univ., Athens. Inst. of Natural Resources.
K. J. Hatcher, and R. C. Chambers.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-117274, Price codes: A05 in paper copy, A01 in microfiche. Environmental Resources Center Report No ERC 14-83, Georgia Inst. of Technology, Atlanta, September 1983. 87 p, 6 Fig, 7 Tab, 9 Ref. OWRT A-094-GA(1), 14-34-0001-1111.

Descriptors: *Georgia, *State agencies, Local governments, Comprehensive management, *Govern-

ment agencies, *Institutional arrangements, Multiple objectives, Water resources management.

The natural resources of water quality, water quantity, surface water, and ground water are currently managed through water programs in various federal, state and local agencies. More efficient water management and resources utilization would result if agency programs were better coordinated to manage the water resources and water users as a system. This report seeks to facilitate more coordinated water resources management by providing a compilation and summary of water management activities by local, state, federal, and private organizations in Georgia.
W84-00202

6F. Nonstructural Alternatives

ANALYSIS OF TAX INCENTIVES FOR INTENSIVE IRRIGATION DEVELOPMENT IN THE NEBRASKA SANDHILLS,
Nebraska Univ.-Lincoln. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W84-00005

SETTING EFFLUENT AMMONIA LIMITS TO MEET IN-STREAM TOXICITY CRITERIA,
Washington State Dept. of Ecology, Olympia.
W. E. Yake, and R. K. James.
Journal of the Water Pollution Control Federation, Vol 55, No 3, p 303-309, March, 1983. 7 Fig, 11 Ref.

Descriptors: *Ammonia, *Regulations, Effluents, Legislation, Decision making, Monitoring, Water pollution control, Water quality control, Quality control, Seasonal variations, *Toxicity, Effluent standards, Effluents, *Water quality standards, *Washington.

Statewide policy guidelines for setting effluent ammonia limits are presently being sought by the Washington State Department of Ecology. A method for setting effluent ammonia limits that protect against in-stream, un-ionized ammonia toxicity is described. The method described uses fixed-station, long-term receiving water data and river flow records to establish seasonal effluent limitations. Seasonal limits provide the ability to meet the in-stream criterion with a high degree of reliability while simultaneously minimizing the need for additional construction of treatment works and higher operating costs at treatment facilities. This desirable result is particularly marked in the case of un-ionized ammonia, because it turns out that this highest risk season, summer at low flow, is also the season during which in-plant nitrification is most easily achieved and maintained. The method accounts for seasonal functions in pH, temperature, flow, and background ammonia concentrations. It can be applied consistently across the state. It uses currently available data, and thus delays in data collection and lack of the resources needed to plan, execute, and publish intensive receiving water survey results are not a problem. The method is also flexible enough to accommodate policy decisions needed to implement the method. (Baker-FRC)
W84-00017

THE IMPACT OF FLOODPLAIN REGULATIONS ON RESIDENTIAL LAND VALUES IN OREGON,
Oregon State Univ., Corvallis. Dept. of Geography.
K. W. Muckleston.
Water Resources Bulletin, Vol 19, No 1, p 1-7, February, 1983. 4 Fig, 2 Tab, 2 Ref.

Descriptors: *Flood plains, *Regulations, *Land appraisals, *Oregon, Flood control, Legislation, Non-structural alternatives.

Ambiguities about the relationship between floodplain regulations and residential land values were investigated. Clarification of this relationship should facilitate the long-delayed implementation of a more comprehensive and successful approach to flood hazard mitigation than is presently employed. The suggestion that current floodplain regulations significantly depress appreciation rates of regulated lands relative to those of similar unregulated lands was rejected in most cases. When this suggestion was accepted the circumstances rendered the conclusions tenuous. Problems and issues facing this type of research are presented in case studies of two of the research study areas. However, it is pointed out that conclusions at this juncture should remain tentative because the research could not be carried out under ideal conditions. First, all of the criteria for establishing uniform study areas could not be met, even though much attention was paid to this step in the research process. One particular problem is that considerable development had taken place in some of the study areas prior to the implementation of floodplain regulations. Under these conditions a valid question regarding the relation between regulation and land values appears to be whether any possible negative aspects of land use regulations are not outweighed by the positive attributes of flood insurance, which under the NFIP becomes available concurrent with the implementation of regulations. (Baker-FRC)
W84-00089

ENHANCING THE EFFECTIVENESS OF PUBLIC PARTICIPATION IN DEFINING WATER RESOURCE POLICY,
Wisconsin Univ.-Madison. Water Resources Center.
L. -J. Schierow, and G. Chesters.
Water Resources Bulletin, Vol 19, No 1, p 107-114, February, 1983. 1 Fig, 1 Tab, 35 Ref.

Descriptors: *Public policy, Water resources development, *Education, Training, Management, Water management, Decision making, *Water policy.

The scope of the instructional deficiency in the participations of the public in defining policy for water resource development was studied. While millions of dollars are spent annually on public involvement programs, many of the goals for these programs are not achieved. One reason may be the lack of emphasis on educational programming. Professional expertise which is available to guide the development and implementation of instructional programs is not being used, and existing informational programs are inadequate to meet educational objectives. Eleven interdependent educational goals are identified such that achievement of each goal improves the likelihood of achieving others. Evaluations indicate that the incorporation of mechanisms employed by professional educations is a potential remedy to the lack of knowledge apparent at the public level. An individualized educational program is recommended to meet the needs of a heterogeneous adult audience. (Baker-FRC)
W84-00112

6G. Ecologic Impact Of Water Development

A COMMENT ON THE PAPER BY JOHN R. M. KELSO AND GARY S. MILBURN: 'ENTRAINMENT AND IMPINGMENT OF FISH BY POWER PLANTS IN THE GREAT LAKES WHICH USE THE ONCE-THROUGH COOLING PROCESS, (J. GREAT LAKES RES. 5:182-194, 1979),
Toledo Edison Co., OH.
J. Scott-Wasilk, R. Kunshek, D. T. Michaud, A. E. Gaulke, and J. H. Balletto.
Journal of Great Lakes Research, Vol 7, No 4, p 491-497, 1981. 3 Tab, 23 Ref.

Descriptors: Fish populations, *Entrainment, *Impingement, Powerplants, Hydroelectric plants, Cooling, Great Lakes, *Fish handling facilities.

An evaluation is presented of an earlier assessment of entrainment and impingment impact of the 89 steam-electric generating stations on Great Lakes fish stocks. The original evaluation inappropriately compared 1975-76 impingement losses to outdated commercial catch statistics for years prior to 1970. More recent statistics for one region of the Great Lakes which has supported a commercial fishery for almost 100 years document the supposition that the commercial catch is increasingly dominated by ecologically less desirable, but very abundant species. The earlier evaluation stated that 85% of the total numbers of fish impinged and entrained are of these very abundant species. Despite the large numbers of impinged and entrained fish, the numbers of alewife caught commercially in Lake Michigan have been steadily increasing over the past several decades. The earlier report estimated that large numbers of fish larvae were entrained and killed at power plants. However, as with impingement, the impact of the large number of larvae entraind is small when compared with the probable total number of larvae in the lakes. Entrainment losses in the earlier study are also represented as improbably severe in that entrainment mortality is assumed to be 100%, whereas it has been shown to vary between 30 to 100% depending upon species and life stage. This evaluation concludes that the power plant entrainment and impingement have only a minimal impact on the fisheries of the Great Lakes. This evaluation is responded to by an author of the original paper, who maintains that once-through cooling extracts fish which are not utilized in any way and which are in excess of 25% of the total annual commercial fish havest. (Baker-FRC)
W84-00019

PRODUCTION OF FILTER-FEEDING TRICHOPTERA IN AN IMPOUNDED AND A FREE-FLOWING RIVER,
Royal Ontario Museum, Toronto. Dept. of Entomology.
C. R. Parker, and J. R. Voshell, Jr.
Canadian Journal of Zoology, Vol 61, No 1, p 70-87, 1983. 2 Fig, 8 Tab, 65 Ref.

Descriptors: *Aquatic productivity, *Dam effects, *Ecological effects, Aquatic population, *Food chains, *Zooplankton, Aquatic animals, Environmental effects, Crustaceans, Trophic level, Population dynamics, Reservoirs, Seston, *Virginia, North Anna River, South Anna River.

The productivity of five species of Hydropsychidae and two species of Philoptamidae was examined at two sites on the impounded North Anna River and two sites of the free-flowing South Anna River of Virginia. Total production was highest at the site immediately below the dam (3250.0 kilograms dry weight/ha/yr), while at the other sites production ranged from 94.0 to 515.1 kilograms dry weight/ha/year. Analyses of trophic dynamics, seston energetics, and rates of consumption showed that zooplankton released from the reservoir greatly enriched the seston which corresponded to the size of the zooplankton released from the reservoir and the capture net mesh size of the hydropsychids. The high density of filter feeders below the dam reduces the food quality of the seston and limits production downstream. Detailed biotic interaction which might effect the dynamics of such an ecosystem are also considered. (Geiger-FRC)
W84-00079

SOME HYDROTECHNICAL PROBLEMS RELATED TO THE CONSTRUCTION OF A CAUSEWAY IN THE ESTUARY OF THE PETITCODIAC RIVER, NEW BRUNSWICK: DISCUSSION,
Northwest Hydraulic Consultants, North Vancouver (British Columbia).
V. J. Galay.
Canadian Journal of Civil Engineering, Vol 10, No 1, p 169-170, 1983. 1 Fig, 4 Ref.

Descriptors: *Dam effects, *Silting, *Tidal effects, Estuaries, Drainage, Petitcodiac River, *New Brunswick.

The writer reinforces the conclusions presented in the above titled paper, written by D. I. Bray et al. and published in Canadian Journal of Civil Engineering, Vol. 9, pages 296-307, 1982, with respect

to the rapid siltation of an estuary on the seaward side after construction of a causeway or other obstruction. In several projects of this type silt has obstructed the gates, making them inoperable, and preventing drainage during low tide and in wet seasons. (Cassar-FRC)
W84-00081

INFLUENCE OF A NEW IMPOUNDMENT ON PESTICIDE CONCENTRATIONS IN WARM-WATER FISH, SAYLORVILLE RESERVOIR, DES MOINES RIVER, IOWA, 1977-78,
Minnesota Pollution Control Agency, Roseville.
S. Y. T. Leung, R. V. Bulkley, and J. J. Richard.
Pesticides Monitoring Journal, Vol 15, No 3, p 117-122, December, 1981. 1 Fig, 3 Tab, 10 Ref.

Descriptors: *Fish, *Reservoirs, *Pesticide residues, Fate of pollutants, Rivers, Insecticides, Herbicides, DDT, Dieldrin, Heptachlor, Saylorville Reservoir, *Iowa, Des Moines River.

Pesticide concentrations were determined in warm water fish caught above, within, and below the newly impounded (April 1977) Saylorville Reservoir, on the Des Moines River, Iowa, from October 1977 to October 1978. No atrazine, alachlor, or cyanazine were detected in fish samples. Dieldrin generally occurred in greater concentrations than the other insecticides identified, total DDT and its isomers and heptachlor epoxide. Levels of dieldrin and heptachlor epoxide were significantly higher in river carpsucker from the reservoir than from the river. Other fish species (gizzard shad, common carp, channel catfish, white crappie, walleye, and largemouth bass) showed no trends in pesticide levels as related to site of collection. Mean pesticide concentrations (micrograms per kg wet weight) for all fish at the reservoir and downstream stations were: dieldrin, 49-55; total DDT, 55-72; and heptachlor epoxide, 6-9. (Cassar-FRC)
W84-00197

7. RESOURCES DATA

7A. Network Design

INTEGRATING A GROUND WATER DATA RECONNAISSANCE PROGRAM INTO A MINERAL EXPLORATION PROGRAM,
Mobil Coal Producing, Inc., Denver, CO. Environmental Technical Services.
J. M. Kaufman, and T. D. Vandell.
Mining Engineering, Vol 35, No 2, p 137-139, February, 1983. 4 Fig.

Descriptors: *Mineral industry, *Geohydrology, *Exploration, Drilling, Groundwater, Data collection, Water quality, Water level.

Costs may be saved by integrating a groundwater data reconnaissance program into the later phases of mineral exploration. Water data is most easily obtained from exploration holes drilled with rotary drilling equipment using air or water as the drilling fluid. For each borehole a geologic and geophysical log should be kept and water samples collected for analysis. Hydrogeologic data which can be obtained from these studies include static water levels, permeability, air lift production rate, transmissivity, and water quality. (Cassar-FRC)
W84-00096

EVALUATION OF WATER QUALITY SAMPLING LOCATIONS ON THE YUKON RIVER,
Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region.
P. H. Whitfield.
Water Resources Bulletin, Vol 19, No 1, p 115-121, February, 1983. 4 Fig, 5 Tab, 14 Ref.

Descriptors: *Water quality, *Evaluation, *Sampling, Samples, Yukon River, *Alaska, Yukon Territory, Monitoring.

An approach was developed and used to evaluate sampling locations on the Yukon River between Dawson in the Yukon Territory and Eagle, Alaska. Spatial heterogeneities and temporal variations in a number of water quality variables at four locations on the Yukon River were examined to determine an optimum sampling location and to estimate a necessary frequency and density of sampling for long term monitoring. At three of the four study sites it was difficult to obtain representative samples due to the presence of extensive lateral heterogeneities. These heterogeneities occur because of a lack of mixing between the Yukon River and the major tributaries upstream from Dawson. Only one of the sampling locations was spatially homogeneous enough to provide representative samples. Concentration variations over the annual cycle are very large, often as much as two orders of magnitude. Estimates are made of the frequency and density with which samples must be collected to be able to detect a 10% difference between annual mean concentrations. The estimated frequencies are so large that such an undertaking would be impractical. More importantly, the assumptions of this analysis are invalid, and time series analysis of fixed frequency samples is proposed as an alternative that is statistically rigorous and requires fewer samples. (Baker-FRC)
W84-00097

7B. Data Acquisition

SAMPLING ACCURACY OF PIT VS. STANDARD RAIN GAGES ON THE FERNOW EXPERIMENTAL FOREST,
Northeastern Forest Experiment Station, Parsons, WV. Timber and Watershed Lab.
J. D. Helvey, and J. H. Patric.
Water Resources Bulletin, Vol 19 No 1, p 87-89, February, 1983. 2 Fig, 1 Tab, 14 Ref.

Descriptors: *Rain gages, *Measuring instruments, *Rainfall, Gages, Precipitation, Sampling, Standard raingages, Pit gages, Hardwood forest, Forest management, Forestry, *West Virginia.

Catch in standard (unshielded) rain gages exposed 3 feet above the surface of the land was compared with catch in pit (buried) gages exposed 1 inch above the surface. The results of the comparison confirm that pit gages can help to rectify the undersampling of rainfall inherent in conventionally exposed standard gages, in wildland observation as well as the usual weather stations. They confirm also that trees surrounding rain gage openings in the forest provide wind shielding inadequate to correct the undersampling in standard gages. Catch in buried gages may reflect orographic increases in rainfall more accurately too; precipitation is known to increase 4 to 8 cm/yr/100 m of elevation. This relation between elevation and precipitation is undetectable in long-term Fernow data based on catch in standard gages, presumably because it is masked by the undersampling effect of stronger winds at higher elevations. Pit gages caught significantly more rain than did standard gages at each of the four locations tested. Catch increases ranged from 213 to 3.4%. (Baker-FRC)
W84-00114

AUTOMATED PATTERN RECOGNITION OF PHYTOPLANKTON - PROCEDURE AND RESULTS,
Technische Univ., Dresden (German D.R.).
O. Schlimpert, D. Uhlmann, M. Schuller, and E. Hohne.
Internationale Revue Der Gesamten Hydrobiologie, Vol 65, No 3, p 427-437, 1980. 6 Fig, 1 Tab, 5 Ref.

Descriptors: *Automation, *Phytoplankton, *Classification, Asterionella, Fragilaria, Deratium, Melosira, Peridinium, Computers.

Automatic identification of 5 phytoplankton species (Asterionella formosa, Melosira italica, Ceratium hirundinella, Fragilaria crotonensis, and Peridinium bipes) was evaluated using television pictures analyzed by a Robotron 4200 computer. Raster images were subjected to spectral analysis. A feature vector was used to describe the objects independent of their angular position. This permitted characterization in a p-dimension feature space of each genus as a cluster which could be separated from the clusters characterizing other genera by means of discriminance functions. The statistical moments (location and orientation of the separating hyperplanes) required for classification were determined automatically by a learning method. The overall error rate was 6.8%. Errors for individual species were zero for Asterionella, 25% for Fragilaria, and 1-4% for the other 3 species. The rate of rejection (assignment to none of the 5 classes) was 12.8%. The scanning raster used in the study was relatively coarse, (<100 picture elements per colony). (Cassar-FRC)
W84-00300

RESULTS OF TOXIC ACTION OF WATER POLLUTANTS ON DAPHNIA MAGNA STRAUS TESTED BY AN IMPROVED STANDARDIZED PROCEDURE (ERGEBNISSE DER SCHADWIRKUNG WASSERGEFAHRDENDER STOFFE GEGEN DAPHNIA MAGNA IN EINEM WEITERENTWICKELTEN STANDARDISIERTEN TESTVERFAHREN),
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
G. Bringmann, and R. Kuhn.
Zeitschrift fuer Wasser und Abwasser Forschung, Vol 15, No 1, p 1-6, 1982. 14 Tab, 5 Ref.

Descriptors: *Water pollution effects, *Toxicity, Sublethal effects, Median tolerance limit, Data acquisition.

A largely standardized procedure for testing the potential toxic action of water pollutants as measured by the immobilization of Daphnia magna Straus is presented. Details of the methodology, application, evaluation, and results are discussed. The standardized test strain IRCHA served as a test organism. The stock cultures were fed standardized dry algae, and toxicity testing was performed in a chemically and physically defined standardized culture medium. When evaluating the test results, the medium tolerance limits (EC 50) values of the substances tested were determined according to a mathematically standardized method. The toxicologically relevant range of the EC was determined by establishing the EC 0 and the EC 100. The results of 183 pollutants are listed in tables classified by substance groups. About 30 pollutants were found to toxicologically effective at concentrations of less than 10 milligrams per liter. These pollutants include silver, mercury, copper, thallium, and cadmium cations; dichromate, cyanide, sulphur, arsenate, and selenite anions; such inorganic substances as hydrogen peroxide and ammonium hydroxide; and such organic substances as hydroquinone, 4-nonylphenol, and pentachlorphenol. (Carroll-FRC)
W84-00325

7C. Evaluation, Processing and Publication

GEOPROCESSING - A WATER DISTRIBUTION MANAGEMENT TOOL,
D. K. O'Day.
Public Works, Vol 114, No 1, p 41-43, January, 1983. 3 Fig, 3 Ref.

Descriptors: *Data processing, *Water mains, *Geography, *Water distribution, Dual Independent Map Encoding (DIME), Leakage, Data collections, Urban areas, Maps, Rehabilitation, *Geoprocessing.

Geoprocessing combines geographic analysis and data processing. It can be useful in managing water distribution systems by integrating routine, readily available field data into a geographically oriented data system for network analysis models, water loss control programs, and maintenance/rehabilitation planning. The Dual Independent Map Encoding (DIME) base file provides a computerized description of street networks in 256 U.S. metropolitan areas. An example of geographically processing water utility data features preparation of a summary of water main breaks for each segment of the main in the distribution system, given several thousand water main break reports. This report can identify high break mains, leak prone mains,

and low C-value mains to aid in planning rehabilitation programs. (Cassar-FRC)
W84-00196

8. ENGINEERING WORKS

8A. Structures

EVALUATION OF THE ECONOMIC EFFICIENCY OF THE OPERATION OF A HYDROELECTRIC STATION ON THE BASIS OF SPECIFIC WATER DISCHARGES,
G. S. Kiselev, and A. A. Kuprik.
Hydrotechnical Construction, Vol 15, No 9, p 533-538, 1981. 3 Fig, 3 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 9, p 24-26, September, 1981.

Descriptors: *Economic efficiency, *Hydroelectric plants, *Specific discharge, Reservoir operation, Operation policies, Electric power production, Flow measurement, USSR.

The economic efficiency of a hypothetical hydroelectric station was calculated by comprising actual specific discharge and specific discharge determined from the assigned operating regime. This procedure compensates for differences in head and daily load assignments. The resulting efficiencies provide a basis for incentives to operate the plants at maximum efficiency. In addition, a group of interconnected hydroelectric and thermal powerplants may be rated for efficiency on a more uniform basis. (Cassar-FRC)
W84-00142

SHANGHAI TUNNEL PROJECTS SPUR CONSTRUCTION INNOVATIONS,
Shanghai Tunnel Construction Co. (China).
W. Z. Xin.
Civil Engineering (New York), Vol 52, No 12, p 36-38, 1982. 4 Fig.

Descriptors: *Tunnels, *Water conveyance, *Piping, Design criteria, Engineering, Water pipes.

Underground construction in soft ground is newly developed in Shanghai. Pipe jacking was introduced into the area over two decades ago for a short sewer tunnel under a woolen mill workshop. The use of pipe jacking spread, and the long distance record comprised the completion of a 518.99 m push of 2600 mm diameter steel pipe under the Yung River. The major technical innovations of long distance pipe jacking include: the introduction of intermediate jacking stations in association with bentonite lubrication to lower the total thrusting force, which increases in direct proportion to the distance of pipe jacking; and the introduction of an articulated shield which facilitated high accuracy both in alignment and grade. The shield used for long distance pipe jacking is a special design, built on three segments with watertight overlapping joints for articulation. The third innovation was the introduction of pressurized face shield with 'shelves' used to support the sandy or clayey ground. Welded steel pipes were used in the long distance projects both for withstanding the high jacking force and external ground pressures and for watertightness. Reinforced concrete pipes have also been developed to withstand the erosive effect of the effluents in long distance sewage piping. (Baker-FRC)
W84-00348

8B. Hydraulics

ON WATER WAVES PRODUCED BY GROUND MOTIONS,
Montpellier-2 Univ. (France). Dept. de Physique Mathematique.
P. C. Sabatier.
Journal of Fluid Mechanics, Vol 126, p 27-58, 1983. 20 Ref.

Descriptors: *Waves, *Model studies, Seismics, Tsunamis, Mathematical equations, Mathematical studies.

A linear and irrotational model is constructed to represent the formation of water waves by ground motions of a sloping bed. A survey of the constant-depth case, given first, helps in understanding the mechanism of formation and, in this oversimplified case, wave propagation away from a source, which is usually very asymmetric. The importance of asymmetry, which produce trapped waves, is illustrated by an estimate of the propagation in a three-dimensional case. The formation of waves by a ground motion on a slope is studied in depth. The problem is reduced to linear integral equations of the first kind. A source-response pair is constructed using an inversion technique. A general approximate solution is derived in both the two and three dimensional cases. Results for the sloping-bottom case are given for small times. They give initial values of surface displacement. They also enable the determination of important physical parameters in the ground motion to be made and the efficiency of wave production to be evaluated. (Baker-FRC)
W84-00021

BEND LOSSES IN DROP INLET SPILLWAYS,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
C. D. Smith.
Canadian Journal of Civil Engineering, Vol 10, No 1, p 1-8, January, 1983. 8 Fig, 6 Tab, 8 Ref.

Descriptors: *Spillways, *Hydraulic loss, *Eddies, Design criteria, Hydraulic design, Spillway channels, Drop inlet spillway, Bend loss.

Several configurations for the 90 degree bend in drop inlet spillways were subjected to hydraulic tests. Cross sections were square and the ratio of the inside radius of the bend to the side dimension of the cross section was 0.5 for each of the 5 designs: (1) curved bend (both sides curved), (2) square bend (both sides angular), (3) outside curve (outside curved, inside angular), (4) inside curve (outside angular, inside curved), and (5) curve and bevel (inside curved and outside beveled). Loss coefficients determined over a range of flow velocities and heads were: curved bend, 0.27; square bend, 1.3; outside curve, 1.29; inside curve, 0.52; and curve and bevel, 0.37. These results show the importance of the inside curve and the unimportance of the outside curve. Construction costs are considerably higher for curved structures than for the square structure. Therefore design can be simplified by omission of the outside curve while retaining the flat bottom as a convenient base for construction. The inside curve design is an economical and effective compromise between the expensive curved design and the inefficient square bend. (Cassar-FRC)
W84-00090

SIZING WATER WELLS FOR GROUND WATER HEAT PUMPS: PART II,
T. E. Gass.
Water Well Journal, Vol 34, No 5, p 36-37, May, 1980. 1 Fig.

Descriptors: *Storage requirements, *Storage tanks, *Water storage, *Pump wells, *Water pressure, Storage capacity, Pumps, Wells, Water demand, Groundwater, Recycling.

The primary purpose of the pressure tank is to ensure adequate water pressure to all house fixtures while providing enough water storage to avoid frequent pump starts and stops. The storage facility must be large enough to meet peak demands while allowing some reserve. The hydropneumatic pressure tank is commonly used for water storage situations where demand does not significantly exceed pump capacity. In some parts of the country, the well itself may provide substantial storage. Storage tanks should be used only in conjunction with a groundwater heat pump. A pump must be sized to meet the water demand of the heat pump and to deliver the water at a desired pressure. A 2,400 gallon tank will meet the continuous demand of the heat pump for 8 hr even if the family diverts 480 gallons of well water for domestic use. To conserve water, some of the water leaving the heat pump may be recycled back to the storage tank. When heating and cooling needs increase, there must be some input of groundwater regulated by thermistors. (Geiger-FRC)
W84-00295

WATER HAMMER WITH BREAKS IN THE CONTINUITY OF THE LIQUID,
L. S. Gerashchenko.
Fluid Mechanics, Vol 10, No 2, p 135-141, 1981. 4 Fig, 11 Ref.

Descriptors: *Water hammer, *Fluid mechanics, *Pressure spikes, *Pipelines, Pressure, Water mains, Pipe flow.

New experimental data are given on the pressure spikes in pipes carrying liquids under conditions of water hammer with breaks in the continuity of liquid. In the experimental setup, the water hammer originated at the end of a 51.5 mm diameter, 46.9 m long steel pipe. The pressure variation that occurred during the first phase fitted the Zhukovskiy theory. The pressure reduction period was longer than the impact phase, which suggests onset of breaks in continuity. The start of the third water hammer phase was accompanied by an instantaneous high-frequency pressure spike. Such surges, with amplitudes decreasing below that of the pressure spike, are observed at the start of successive add phases that follow periods of breaks of continuity. It is concluded from comparison of the experimental results with the theory of development of cavitation that the pressure spikes result from forces generated by simultaneous collapse of individual cavitation bubbles upon overall rise of pressure in the liquid. By speeding up the film travel rate it was possible to obtain larger-scale oscillograms of pressure changes immediately following pressure spikes. The pressure curve during the phase with maximum possible pressure reduction shows up as a horizontal line. At the end of the reduction period there appear small pressure fluctuations, which precede the spikes. Further study of oscillograms of water hammer produced by closing of a rapid acting slide-valve at the start of a steel pipeline suggests that cavitation bubbles during the runs did not collapse simultaneously. The findings of this study elucidate the physics of the phenomenon and should be treated as a point of departure in detailed quantitative studies of water hammer with breaks in continuity. (Baker-FRC)
W84-00311

8C. Hydraulic Machinery

TAPPING GROUND WATER FOR HEATING AND COOLING,
Flack and Kurtz, New York.
D. I. Stillman, V. W. Uhl, and M. R. Warfel.
Consulting Engineer (St. Joseph), Vol 60, No 3, p 59-62, 1983. 2 Fig, 1 Tab.

Descriptors: *Groundwater, *Heating, *Cooling, System design, Design criteria, Engineering, Water resources development.

The cost effectiveness of a ground water source heat pump system depends on the type of building being heated and/or cooled, ground water availability, the ground water temperature, and the location of the wells in relation to the building. Well water source heat pumps take advantage of a constant source of low-grade heat in the form of ground water. The first step in designing a well water source heat pump system is estimating the peak heating and cooling loads for the building. After test wells have been drilled, a chemical analysis of the well water must be made. Careful analysis of the corrosiveness of the water and the materials to be used within the system will enable the cost of the piping, heat exchangers, and condenser and evaporator tubes to be kept to a minimum. A case history is described in which a groundwater source heat pump system is to be used to heat and cool a 130,000 sq ft commercial office building at the Princeton Forrestal Center in Princeton, New Jersey. The basic approach calls for formulation of heating/cooling requirements

and estimates of ground water pumping requirements, a preliminary hydrologic study to assess the potential for developing the required quantities of ground water from on-site aquifers, to investigate possible alternatives for disposal of heat pump discharge water and to define the pertinent regulatory requirements; a field drilling investigation, permit application submission and approval, and the installation of pumps in production wells and other areas. (Baker-FRC)
W84-00024

RETROFIT OF HYDROPOWER CAPACITY AT CONEMAUGH DAM,
Villanova Univ., PA. Dept. of Civil Engineering.
R. A. Chadderton, and J. E. Niece.
Water Resources Bulletin, Vol 19, No 1, p 101-106, February, 1983. 6 Fig, 4 Tab, 4 Ref.

Descriptors: *Design criteria, *Powerplants, Turbines, Hydroelectric power, Dams, Energy, Economic aspects, Hydraulic machinery, Hydraulic equipment, *Pennsylvania, Conemaugh Dam.

Studies were conducted in the Pittsburgh District relative to the addition of hydroelectric power generating facilities at the existing Conemaugh Dam in Pennsylvania. Selection had already been made of 8, 10, 15 and 20 megawatt (MW) total installed capacities for further study. Appropriate installation configuration for each of these four preselected installed capacities was sought, along with data concerning the conceptual design and associated cost estimates for each proposed configuration. Based on the results, the layout preferred consists of the construction of a powerhouse on a portion of the stilling basin apron to enclose multiple Standard Tube turbines and generators. The number and size of the turbine generator units will depend on the total installed plant capacity. The cheapest energy, on a cost per kilowatt hour basis, would be derived from a configuration including two Standard Tube turbines of 4 MW capacity each. The estimated construction cost for this option was about $1200 per kilowatt. Further consideration must be given to the detailed design of powerhouse roof and bearing walls so as to assure structural adequacy under spillway discharge, anchoring of stilling basin slabs, and a model study for the plan. (Baker-FRC)
W84-00127

SPRING-OPERATED SEMIAUTOMATIC IRRIGATION VALVES,
Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center.
A. S. Humpherys, E. Oest, and D. A. Young.
Transactions of the ASAE, Vol 26, No 1, p 134-136, 140, 1983. 5 Fig, 6 Ref.

Descriptors: *Valves, *Mechanical equipment, *Irrigation, Pipelines, Pressure surges, Sprinkler irrigation.

Torsion spring operators for standard low pressure butterfly type irrigation valves are described. These are used with 24 hr timers to semiautomate gated pipe irrigation systems and are particularly well suited for use with flow-though single pipeline systems. They are currently marketed in 150 mm (6 in.), 200 mm (8 in.) and 250 mm (10 in.) diameter sizes. The valve is normally open and is controlled by the time so that it opens at the end of a predetermined closed time period. The valve performed well in field tests in the Grand Valley of Colorado, where it is presently being used. A valve made to operate in the reverse mode by closing when tripped was briefly tested. However, it operated similar to a check valve and closed too suddenly for most conditions. It could be used in this manner at a turnout below a supply ditch, for example, where the upstream pipe length is very short. Otherwise it could create undesirable pressure surges in the pipeline. (Baker-FRC)
W84-00185

PROJECT STUDIES AND RESEARCH WORK CONCERNING BUTTERFLY VALVES AS USED IN WATER POWER STATIONS AND RETARDING BASINS (PLANUNGSKRITERIEN UND FORSCHUNG BEI DROSSELKLAPPEN FUR KRAFTWERKSANLAGEN UND RUCKHALTEBECKEN),
Technische Hochschule, Darmstadt (Germany, F.R.). Fachgebiet Hydraulische Maschinen und Anlagen.
J. Osterwalder.
Wasserwirtschaft, Vol 71, No 12, p 368-372, December, 1981. 7 Fig, 1 Tab, 8 Ref.

Descriptors: *Hydroelectric plants, *Hydraulic valves, *Retarding basins, Project planning, Model testing, Valves.

Depending on the scope of application and their specifications, butterfly valves have to fulfill various requirements. Questions relating to plant security, economic aspects, and hydraulic behavior are usually of considerable importance during the planning of water power stations and retarding basins. Experimental investigations with models provide the best solutions to these questions. Although a number of publications deal with information on butterfly valves for water power stations, little information is available concerning the butterfly valves with eccentrical shutters generally used for retarding basins. Recent research in this area has included the development of model tests which enable a judgement regarding such situations in the planning phase, minimizing risks and disagreeable surprises. In many cases, necessary design modifications or changes in construction can be identified early enough to make suitable corrections. The importance of these butterfly valves in retarding basins should not be judged on the bases of their relatively low cost, but rather on the basins of the problems which may result from their failure. (Carroll-FRC)
W84-00313

SMALL HYDRO FROM A SUBMERSIBLE PUMP,
Canterbury Univ., Christchurch (New Zealand). Dept. of Civil Engineering.
E. P. Giddens, W. Spittal, and D. B. Watson.
International Water Power and Dam Construction, Vol 34, No 12, p 33-35, December, 1982. 5 Fig.

Descriptors: *Pumps, *Hydroelectric power, Submersible pumps, Hydraulic machinery, Pump turbines, Generators.

A conventional submersible pump and motor, operated in the reverse mode, was tested and approved as a complete, self-contained water turbine and induction generator unit. This system is suitable for power production on the small village scale. The pump was direct-coupled to a single-phase induction motor and generated an autonomous 220V, 50 Hz single-phase supply with a system efficiency nearly the same as in the pumping mode. Improvements are planned to increase efficiency of components on scale-up and provide overspeed control. (Cassar-FRC)
W84-00320

LOW-HEAD WATER MILL LINKED TO CANADIAN GRID.
International Water Power and Dam Construction, Vol 34, No 12, p 76, December, 1982. 2 Fig.

Descriptors: *Turbines, *Water wheels, Hydraulic machinery, Prototypes, Prototype tests, Floats, Hydraulics, Hydraulic design, Hydroelectric power.

Electricity produced by a 6 kW floating watermill was connected to the British Columbia Hydro grid in October 1982. The mill is slung beneath a set of pontoons anchored to the river bed. Three 1.5 m long blades direct the flow. A generator is mounted on the surface. Design of the blades is especially critical because they operate on a vertical axis. The design of the 6 kW machine was based on that of a 4 kW prototype mill which had been operating in the St Lawrence for several months without problems, although the potentially most serious problem, ice, was yet to be encountered. A symmetrical hydrofoil section was selected for the blades, as it is one of the best low drag, high lift sections available. (Cassar-FRC)
W84-00321

FRANCIS TURBINES FOR SMALL-SCALE APPLICATIONS,
Sorumsand Verksted A/S (Norway).
N. Romcke, and J. J. Victory.
International Water Power and Dam Construction, Vol 34, No 12, p 61-65, December, 1982. 6 Fig.

Descriptors: *Turbines, Hydraulic machinery, Materials, Hydraulic design, Francis turbines, Hydraulic equipment, Hydroelectric power.

Francis turbines have been redesigned for use in small hydro schemes. The small-scale turbines use welded steel, cavitation resistant materials, and standardized components. Small units are usually arranged with a horizontal shaft. A standard but flexible design was developed to minimize costs and meet individual requirements. Twelve different models, each representing a specific speed, can be altered slightly to achieve intermediate speeds. Shaft sealing is provided by using 2 or more sealing stages drained off to the tailwater or drainage sump. No lubrication or sealing water is required. Shrinking by the oil pressure method has proven suitable for mounting the runner to the shaft. In some circumstances Francis turbines may be preferred to tubular-type turbines, especially at heads less than 20 m. (Cassar-FRC)
W84-00322

8G. Materials

CALCIUM SULPHATE SCALE REMOVAL DURING OPERATION IN HORIZONTAL TUBE FILM EVAPORATORS,
Hamon-Sobelco, Brussels (Belgium).
J. Moisse.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 169-174, 4 figs. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: Seawater, *Distillation, *Powerplants, Desalination, Horizontal tube film evaporators, Scale removal, Scaling.

Thick scales of calcium sulphate experienced on a horizontal film type evaporator of 1500 cu m/day, operating in the modern power station of FACOA, Venezuela, were easily removed without chemical or mechanical actions, keeping the plant in operation at more than 50% of its rated capacity.
W84-00221

FACTORS AFFECTING THE BRINE SCALING POTENTIAL IN MSF PLANTS,
Albright and Wilson Ltd., Oldbury (England).
K. G. Cooper, L. G. Hanlon, G. M. Smart, and R. E. Talbot.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 175-184, 4 Figs, 2 Tab, 5 Ref. (1st. Vol of the Proc of the Intern Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Distillation, *Multistage flash distillation, Brine scaling.

Laboratory studies, using synthetic brine, have shown that it is possible to quantify the thermodynamic driving force for the formation of alkaline scales by a consideration of saturation pH values for the various scaling species. Scaling potential profiles, using this concept, are presented to illustrate this point and demonstrate how the driving force may be measured at various points in the unvented sections of an operating MSF plant.
W84-00222

EROSION-CORROSION RESISTANCE OF COPPER ALLOW C72200 IN SEA WATER CONTAINING SUSPENDED SAND,
Olin Corp., New Haven, CT. Chemicals Div.
N. W. Polan, M. A. Heine, J. M. Popplewell, and C. J. Gaffoglio.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 223-231, 2 Figs, 3 Tab, 10 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination apparatus, Distillation, *Corrosion resistance, *Copper, Copper alloy C72200.

Copper based alloys have been used frequently in salt water service in applications where thermal conductivity, fouling resistance, and good corrosion performance are required. Under conditions, such as turbulent flow or localized high velocities due to partial tube blockage, a form of accelerated attack known as erosion-corrosion can occur. Many copper base alloys, particularly the cupro nickels, are resistant to this form of attach under normal conditions. In particular, certain alloys such as C72200 have been developed specifically to resist erosion-corrosion. However, another form of erosion-corrosion is sometimes observed in locations where sand becomes entrained with the sea water, for example, in certain Middle Eastern desalting plants and European power generating plants. Previous studies have indicated that the erosion-corrosion resistant C72200 approaches the sand erosion resistant C71640. In addition, temper (and consequent hardness) has proven to be a factor. It appears likely, therefore, that at harder tempers, C72200 may equal or exceed the sand erosion resistance of C71640. Coupled with the excellent erosion-corrosion of the alloy and lower cost due to a much lower nickel content, this new alloy may be an attractive candidate for desalting and heat exchanger use where sand entrainment is a problem.
W84-00227

CORROSION PROBLEMS CAUSED BY BROMINE FORMATION IN MSF DESALINATION PLANTS,
INCO Europe Ltd., Birmingham (England).
J. W. Oldfield, and B. Todd.
In: Desalination, Vol 38, Nos 1/2/3, November 1981. p 233-245, 7 Fig, 25 Ref (1st Vol of the Proc of the Intern Congress on Desalination and Water Reuse, Bahrain, Nov 29-Dec 3, 1981).

Descriptors: *Desalination, Desalination plants, *Corrosion, Multistage flash distillation, , Chlorination, Hydrogen ion concentration, Bromine.

The chlorination of sea water has been considered in detail, with particular reference to the oxidation of bromide ions, already present in sea water, to bromine by the chlorine. Under normal conditions of sea water chlorination, bromide ions will rapidly be oxidized to bromine, hypobromous acid and hypobromite ion, bromine being the predominant form at pH values of 6 and less. The significance of this work to MSF desalination plants is that acid treated plants provide conditions suitable for bromine gas formation in the decarbonator and deaerator. For such plants operating with residual chlorine levels in the range 0.2 to 0.5 ppm the condensates from the steam that has passed through the deaerator into the vent system could well contain between 10-100 ppm Br2; these levels of bromine can cause severe localized corrosion problems with conventional stainless steels. Such corrosion has been observed in practice. Calculations indicate that providing the pH is 6 and the residual chlorine is less than 0.22 ppm at the point of entry to the deaerator, the likely bromine level in the condensate in the vent system will be less than 10 ppm, and this may well be low enough to prevent corrosion of type 316 stainless steel.
W84-00228

STUDIES OF THE LOCALISED-CORROSION BEHAVIOUR OF SOME STAINLESS STEELS, INCOLOY 825 AND TITANIUM IN SEAWATER,
Glasgow Univ. (Scotland). Dept. of Mechanical Engineering.
T. Hodgkiess, and A. Asimakopoulos.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 247-256, 4 Figs, 3 Tables, 11 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Distillation, *Corrosion, Multistage flash distillation, Titanium, Chromium.

The localised-corrosion behaviour of several high-grade materials has been investigated in a range of conditions of relevance to desalination plant. Under the conditions studied, no evidence has been found of pitting, crevice corrosion or stress-corrosion cracking in titanium. The remaining materials, all chromium-containing, have exhibited similar immunity as titanium in the least aggressive environments but, to an extent depending upon the material and conditions, they have been found to be susceptible to pitting and crevice corrosion in the more severe conditions featured in this work. The relevance of the observations to distillation-plant operation is discussed.
W84-00229

ACID CLEANING AND PASSIVATION OF POWER PLANT CONDENSERS AND DESALINATION PLANTS,
Rome Univ. (Italy). Ist. di Chimica Applicata ed Industriale.
R. Cigna, A. de Maio, L. Giuliani, and G. Gusmano.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 269-279, 8 Fig, 4 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination plants, Cleaning, Corrosion control, Powerplants, *Tubes, Copper, Alloys.

Acid cleaning and passivation treatments of copper alloy tubes are described. The suitability of corrosion monitoring to follow each step of such operation is demonstrated. To regenerate a clean surface on copper alloy tubes after improper conservation or after corrosive conditions during service, an acid cleaning and pre-passivation treatment has proven to be a very useful and industrially viable method. Such a treatment has definite advantages over any mechanical cleaning method as far as complete dissolution of corrosion products with deterioration of the metallic surface is concerned. The pre-passivation protects the exposed surface in case of further conservation and/or descreases surface reactivity during start-up, thereby allowing a uniform growth of corrosion layers. In case of pitting corrosion, the presence of a Cu-BTA salt film acting as a cathodic inhibitor minimizes any impingement attack which could be provided locally by the pitting morphology.
W84-00231

QUALITY CONTROL PROBLEMS IN COPPER ALLOY TUBES MANUFACTURING,
Rome Univ. (Italy). Ist. di Chimica Applicata ed Industriale.
G. Gusmano, and G. Dall'Omo.
In: Desalination, Vol 38, Nos 1/2/3, November 1981, p 281-293, 16 Fig, 4 Ref. (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Bahrain, Nov. 29-Dec. 3, 1981).

Descriptors: *Desalination, Desalination apparatus, *Corrosion, Copper alloy, *Condenser tubes, Tube integrity.

The quality control of copper alloy condenser tubes cannot be limited to mechanical characteristics, microstructure and chemical composition, but should be extended to cover such not yet fully standardized topics as tube integrity and surface conditions. An analysis of possible defects, with particular regard to internal ones and their relevance of tube life is given together with their causes. Problems related to detection of internal defects by means of eddy current test are also discussed.
W84-00232

PRE-SERVICE CORROSION CONTROL IN MULTIFLASH DESALINATION PLANTS,
Atel SRL, Rome (Italy).
L. Giuliani.
In: Desalination, Vol 38, 1/2/3, November 1981, p 295 (Abstract only) (1st. Vol of the Proc. of the Intern. Congress on Desalination and Water Reuse, Nov. 29-Dec. 3, 1981, Bahrain).

Descriptors: *Desalination, Desalination plants, *Multistage flash, *Corrosion control, Preconditioning treatment, Stainless steel, Copper alloys.

Multiflash desalination plants are characterized by large heat exchange surfaces and presence of noble alloys which might be sensitive to localized corrosion attack during manufacturing, transportation and commissioning. To avoid premature failure, all surfaces must be preserved clean and free from corrosion nucleation until the plant starts its normal operation. A detailed analysis is given of possible corrosion causes and available remedies. Some Pre-conditioning treatments are outlined, especially for stainless steel and copper alloys.
W84-00233

8I. Fisheries Engineering

STUDY OF FISH MANAGEMENT AT THE LG 2 RESERVOIR (TRAVAUX D'AMENAGEMENT PISCICOLE AU RESERVOIR DE LG 2),
Societe d'Energie de la Baie James, Montreal (Quebec).
N. Faubert.
Canadian Water Resources Journal, Vol 7, No 2, p 172-180, 1982. 2 Fig, 2 Ref.

Descriptors: *Reservoirs, *Fisheries management, Reservoir fisheries, Fish populations, Reservoir construction, Reservoir design, Water level fluctuations, James Bay, La Grande Complex, Canada.

In order to determine the likelihood for future reservoirs in the La Grand Complex in northern Canada to be naturally populated by certain species of fish, the Societe d'energie de la Baie James decided to perform a fish management program before the reservoirs are impounded. The program involves deforestation and cleaning of the mouths of some tributaries and littoral sections, which exposes the surface materials more quickly, while preventing the accumulation of ligneous material and the resulting clogging. Building retaining dikes in small bays, such as dike BA-02 at reservoir LG 2, has made it possible to eliminate the effects of fluctuating water levels in the reservoir. In addition, the removal of obstructions from river courses and the creation of fish ways facilitates the movements of fish to sites where they will spawn or feed. (Author's abstract)
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10. SCIENTIFIC AND TECHNICAL INFORMATION

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